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The Erection Traveler, New Quebec Bridge

By H. P. Borden*

In the erection of large bridges, the rapidity and economy of operations are to a very large extent governed by the efficiency of the erection traveler employed on the work. These travelers may be either steel or wood, but on bridges of first importance from an engineering standpoint, steel travelers are of necessity employed.

Available Types of Traveler

On two of the most recent cantilever bridges to be erected, namely, the Blackwell's Island bridge over the East River and the Beaver Bridge over the Ohio, entirely different types of traveler were used. On the former an inside traveler was employed, running on the floor of the bridge and extending above and beyond the trusses on either side. On the Beaver Bridge a smaller traveler was employed which ran on the top chords of the bridge itself. Owing to the fact that the top chords of this bridge were sloping as well as curved, considerable adjustment was necessary at each movement of the traveler to keep it in a horizontal position.

In the case of the old Quebec Bridge two types were used. For the anchor and cantilever arms a high traveler was used, but operating outside of the trusses instead of inside. The tracks for this traveler were supported on special floorbeams attached to and extending beneath and beyond the bottom chords of the main trusses. This type has some advantages to its credit, the most important being the fact that the erection of lateral and sway bracing is not interfered with by the traveler.

For the erection of the smaller members at the end of the cantilever arm and those of the suspended span, a smaller top-chord traveler was used. By this means erection stresses were kept at a minimum when working toward the center of the span.

Fig. 1. The Quebec Bridge Traveler in Working Position

(The traveler track is built on the bridge floor, which rests on inside falsework independent of the truss falsework. Part of lower chord near pier is in place on the truss falsework.)

Inside Deck Traveler Adopted

In the case of the new Quebec Bridge the chief objection to a top-chord traveler is that the panel lengths of the cantilever and anchor arms vary, which would necessitate very elaborate details for distributing the reactions to the panel-points at each movement of the traveler. After thoroughly studying the question, it was decided that a traveler operating from the bridge floor would give better results, and this type was adopted. The difficulty in putting in the bracing between the trusses with this type of traveler was overcome in the anchor arm by the program of erection mapped out.

General Program of Erection—

In accordance with this program, the entire floor of the anchor arm was erected first on special falsework and the traveler was moved over this floor to the main pier. The main shoes were then erected on the pier and both chords with their lateral system were supported on another set of special falsework from the main pier to the anchor pier. The traveler was then moved back to the main pier and the web members, with their sway bracing, were erected up to the point where the verticals and diagonals intersect, or to a point slightly above the line of the floor. This operation will be carried right back to the anchor pier, the traveler moving back as the work progresses.

The portal and the upper half of the diagonals and verticals, together with the

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top-chord eyebars, are then erected, the traveler moving toward the river and keeping in advance of all erection work. By this means all bracing can be put in at the time the member itself is erected, all parts of the traveler being clear of this work.

When the traveler reaches the main pier it will naturally reverse the operation and erect the cantilever-arm material in front of it. The bracing in the panel being erected will therefore have to remain out until the traveler is moved one panel ahead. The bracing under the floor, however, can always be put in.

The traveler was erected on special supporting girders on shore, just clear of the abutment, the top of these girders being in line with the girders carrying the traveler tracks on the bridge.

Design of Traveler

The traveler structure consists of a main tower 37 ft. long by 54 ft. wide and 200 ft. high. At the foot the supporting trusses extend to the rear 52 ft. 9 in. in order to give an increased length of base for distributing the load on the trucks. The upper trusses have an

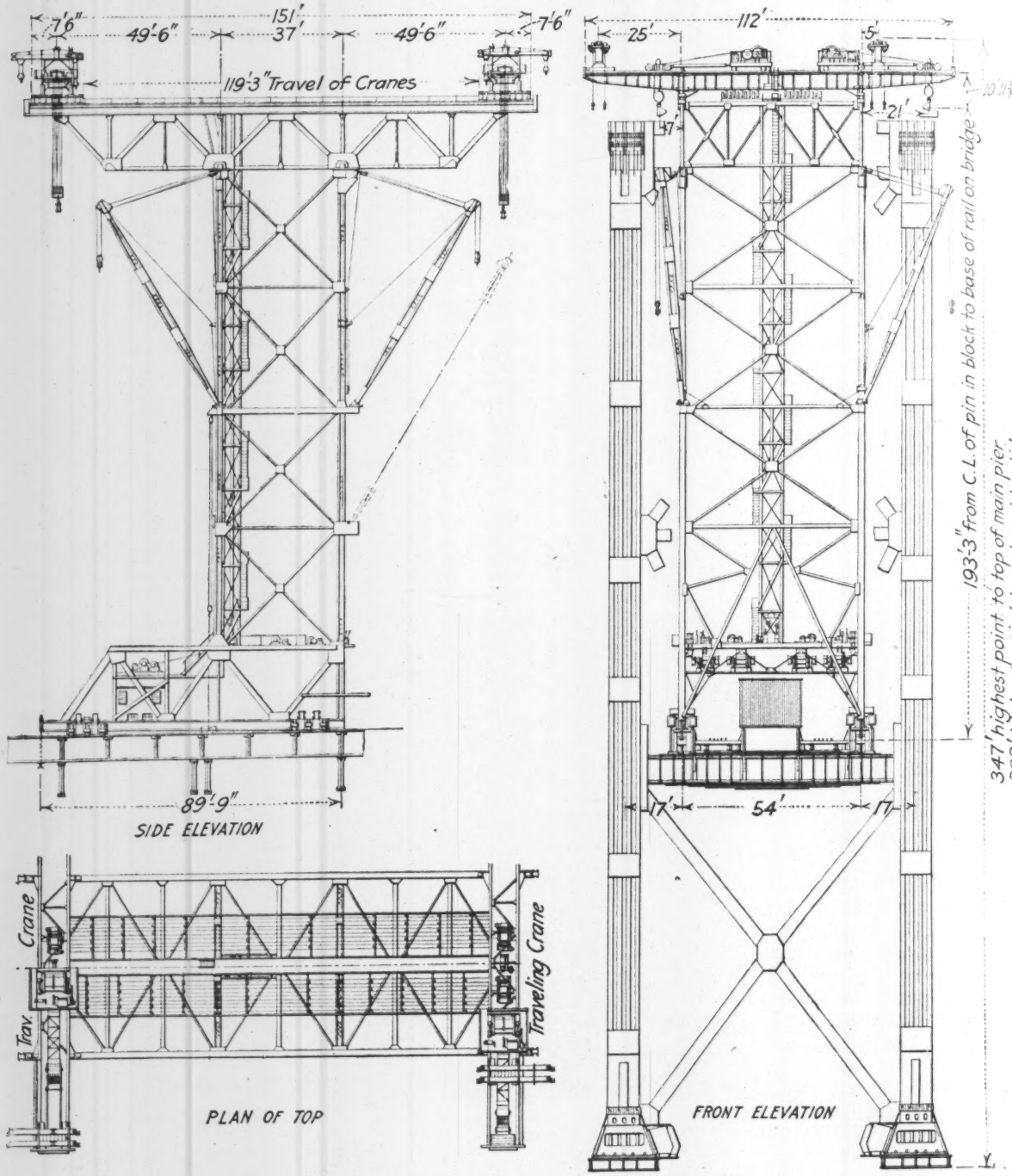


Fig. 2. Erection Traveler for the Quebec Bridge

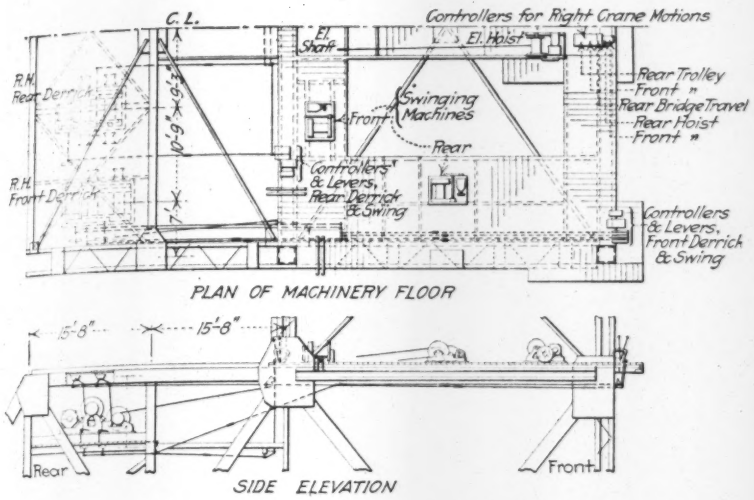


FIG. 3. PLAN OF MACHINERY PLATFORM

overhang fore and aft of 57 ft., upon which run the two heavy cranes which are used in handling the heavier pieces; the main members of these trusses are constructed of nickel-steel. The traveler moves on four tracks, one at each corner, each truck having six wheels distributed in sets of three over two rails placed 6 ft. 6 in. c. to c. In order to distribute the load on the three wheels equally over the rail, the reactions are taken by heavy spiral springs directly over the axle of each wheel. By this means any inequality of the track will be taken up by the springs and the load kept uniformly distributed. On the forward trucks the reactions from these six wheels are distributed by means of needle beams to one 6-in. pin through the webs of the bottom chord of the lower trusses. By

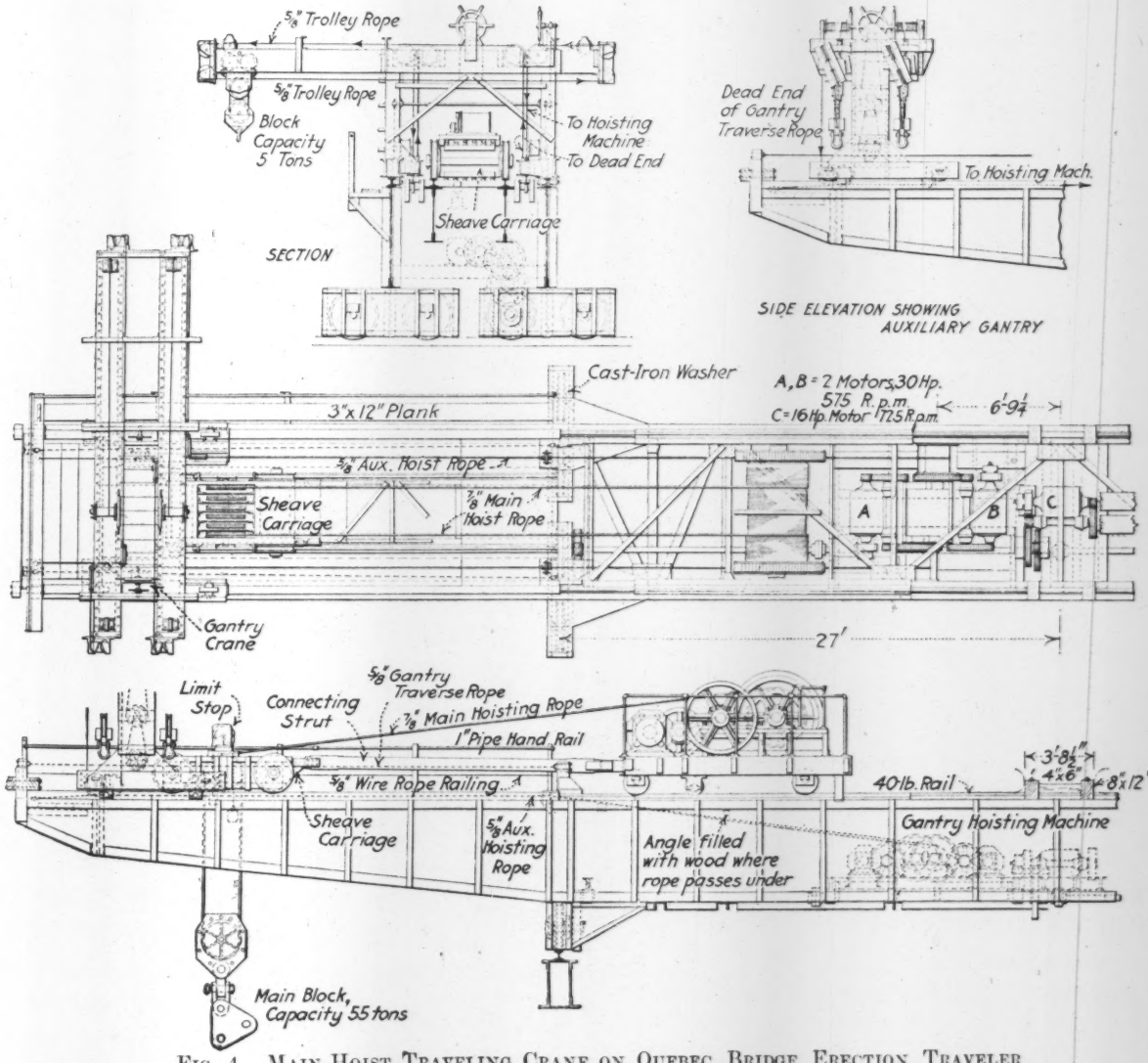


FIG. 4. MAIN-HOIST TRAVELING CRANE ON QUEBEC BRIDGE ERECTION TRAVELER
(Traveler carries two of these cranes.)

this means the entire reaction is concentrated at one point and is absolutely determinate.

As there is a grade on the bridge, some means had to be found for adjustment in order to keep the traveler level when operating. If this grade remained uniform it would be a simple matter, but on account of the deformations of the various members of the cantilever arm the grade is materially accentuated during the early stages of erection and it will also change at each panel. To take care of this, reactions from the rear of the traveler are transferred to the rear trucks by means of a vertical rod 5 in. in diameter, which takes the place of the pin in the forward trucks. When it is necessary to adjust the level of the traveler, the cranes on the top are moved ahead, thus materially decreasing the rear reaction, and then by tightening or releasing the nuts on these rods the necessary adjustment is made.

The traveler is carried on four lines of rails, two on each side of the bridge. The two inside rails are carried on the outer permanent track girders carrying the bridge floor. Outside of these girders is placed another row of special erection girders, 6½ ft. away, supported on falsework or special erection brackets and thoroughly braced to the permanent stringers.

The traveler is not designed to be self-propelling. When it is necessary to move ahead or back, a tackle is attached ahead to the track girders on each side and the cable is overhauled on the spools of the hoisting machines on the first floor. This has been found to work very satisfactorily, the traveler being moved at the rate of about 10 ft. per minute. When it has reached its new position the wheels are locked and shims placed under each corner. By this arrangement the cast-steel wheels of the traveler carry only the dead-load of the traveler itself and not the live-load under lifting operations. When the traveler is moved, the traveling cranes are always moved to the extreme rear of the top trusses, thus giving an almost equal distribution on the forward and rear trucks. When the cranes are engaged in lifting in their forward position, the rear of the traveler is held down by special anchorage tackle to the floor of the bridge.

Machinery and Hoisting Equipment

On the first floor of the traveler, about 18 ft. above the base of rail, are situated the four electric hoists which operate the four steel derrick booms at each corner of the traveler. These hoists are designed for a rope pull of 10,000 lb. with eight layers of ¾-in. wire cable on the drum. The mean rope speed is 150 ft. per min. The drums are 15 in. diameter and 31 in. long. Each hoist has four spools 12 in. diameter and 15 in. long, each spool being loose on the shaft and provided with sliding steel jaw clutch operated by hand lever and quadrant. The motor* is 51 hp. (half-hour rating, 55° rise of temperature), running at 295 r.p.m., with drum controller and brake.

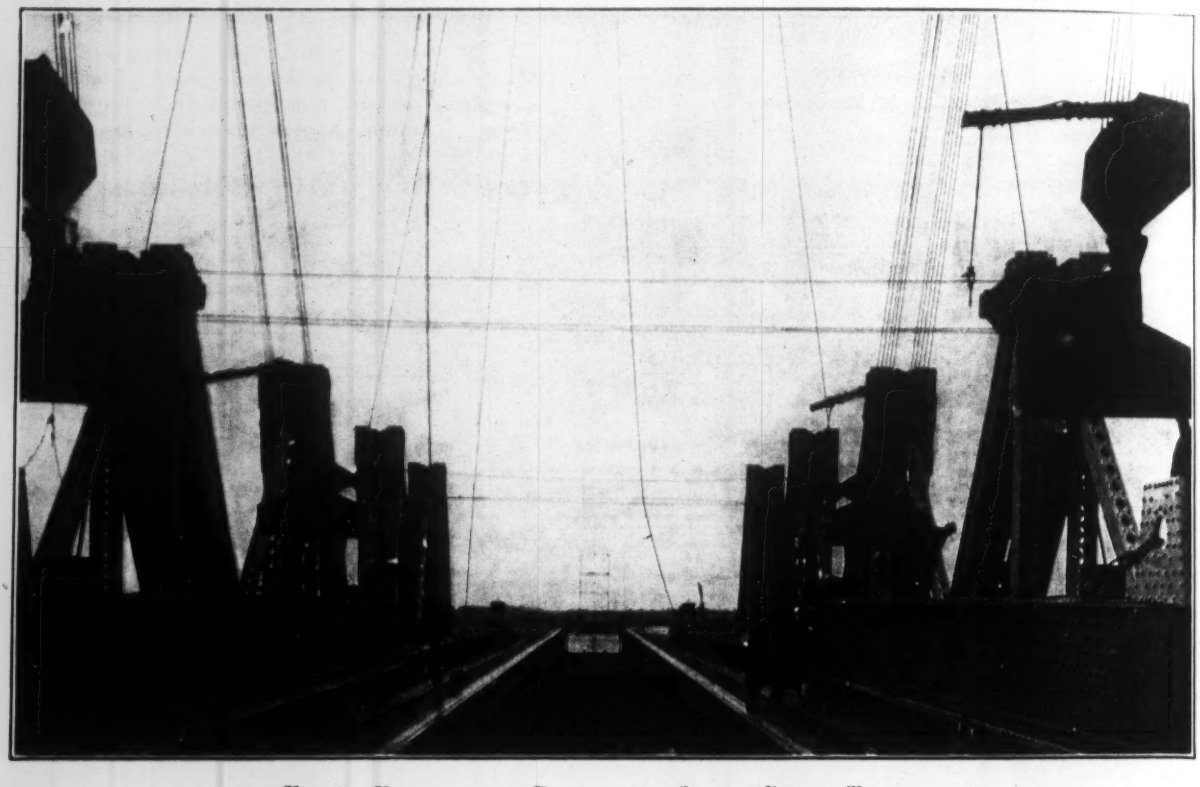


Fig. 5. Erecting the Base of the Quebec Bridge Traveler

The booms are 70 ft. long and can be extended to 90 ft. if desired. They operate from brackets at two different levels, according to the location of the members they are required to handle. The single ¾-in. wire-rope lead from the drum is converted into a four-part tackle at the boom, giving a hoisting capacity of 20 tons in any posi-

*The electric supply is 220-volt direct current. The motors used on the traveler are all of General Electric make.

tion. These booms are used for handling smaller material, such as the lighter web members, bracing and floor material.

On the second floor, 25 ft. above base of rail, are situ-

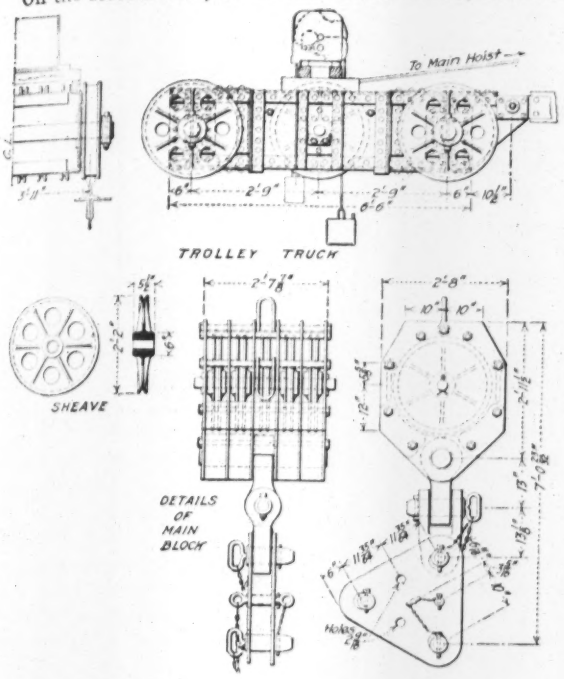


FIG. 6. MAIN-HOIST SHEAVE DETAILS.

ated the four machines required for swinging the booms.

This machine has a drum 13 in. in diameter and 14 in. long, which is operated by a 5-hp. motor having a capacity of 6000 lb. at 25 ft. per min. The motor is fitted with a solenoid brake, which is used principally to block the machine at night and when not in use.

MAIN HOIST CRANES.

On the extreme top of the traveler are located the two traveling cranes which handle the heavier members of the bridge. These cranes, of the usual twin plate-girder type, are 112 ft. long; their girders are 5 ft. 5 in. deep at the center and are spaced 8½ ft. apart. They travel on the top chord of the upper trusses and are each carried on eight 30-in. wheels (in four 2-wheel trucks), but with only one driven wheel at each end of the crane. The crane is operated by a 16-hp. mill-type motor with a working speed of 725 r.p.m. and a capacity of 25 ft. per min. at full load. The cranes are required to climb a 1% grade with a maximum load of 500,000 lb.

Each crane is provided with two electric hoists, the working range of each hoist being necessarily outside the line of the upper trusses of the traveler. On account of the weight of the hoisting machine, it is desirable both from static and economical reasons that this machine be kept as near the center of the traveler tower as possible. As a consequence, the hoisting cable is carried over a sheave carriage placed some 20 ft. in front of the hoisting machine and connected to it by a strut. The hoisting motor is mill type, rated at 80 hp., 500 r.p.m. The controller system is of the magnetic-switch type, and is arranged for dynamic braking with a minimum lowering speed of 12 ft. per minute. The armature has an automatic disk brake capable of holding the maximum load. It is therefore impossible for the load to run away, as, in lowering, the motor works through a resistance greater than the load carried by the crane. The burning out of a fuse applies the full force of the electrical resistance, preventing all movement. In case of failure of the automatic brakes on the armature shaft or in case pinion should break or gear strip, an emergency hand brake is provided. This brake has a sufficient capacity to stop and hold the maximum load lifted. In order to guard against attempting to lift loads greater than those for which the traveler has been designed, special fuses are provided which will blow out when the load reaches a maximum.

Each machine has a lifting capacity of 120,000 lb. at a speed of 12 ft. per min., through a 10-part ⅞-in. wire cable, both ends of which are wound on the drum, thus obtaining a rope speed of 60 ft. per min. The maximum lift of these hoists is about 330 ft., requiring a total length of cable on each machine of approximately 3500 ft. Specially designed self-lubricating blocks are used which, with their shackle, are over 7 ft. high and weigh approximately 1½ tons each.

FIG. 7. TOP OF THE QUEBEC BRIDGE TRAVELER, WITH MAIN-HOIST TRAVELING CRANE

The carriage has a traversing motion of 14 ft., the motive power being a 5-hp. motor, 800 r.p.m. It is driven by means of a rack rail capable of holding the carriage against an end thrust of 30,000 lb. (due to fleet-

ing loads), but the carriage is not required to move against this load.

When handling heavy members off the cars, duplicate members for each truss are lifted simultaneously, thus tending to maintain a more uniform state of equilibrium in the traveler and floor. As the cars are brought in under the traveler on tracks spaced 32 ft., and the hoists operate at a minimum distance of 68 ft. c. to c., the members require to be fleeted out. This is provided for by special fleeting tackle which holds the blocks together until the member is clear of the cars and any obstructions.

At the extreme end of each of the crane girders is an auxiliary gantry hoist of 5 tons capacity. The transverse and longitudinal movements of these gantries are operated by hand power, the hoisting power being, however, supplied by a 30-hp. motor situated at the top floor. These gantry hoists have a limited travel, being used principally for the handling of pins, riveting cages and other equipment in line with the main trusses beneath.

With the exception of the four hoisting engines operating the boom derricks, the electric controls of all machines are located on the second floor or bridge situated 25 ft. above base of rail, or about 175 ft. below the crane girders. One man is thus able to operate the two switchboards which control the travel of both crane girders and the traversing movements and hoisting operations of the four hoisting machines. The hoisting operations of the four auxiliary gantries are also controlled from this floor, by two other sets of control levers, situated one on each side of the floor. By this arrangement the operator is in close touch and has an unobstructed view of all work being done and can anticipate and promptly execute all orders given by the foreman in charge. One mechanician is always at the upper level to oil and keep a general supervision over the mechanical operations of the machines and is at hand to apply the emergency brakes should occasion arise.

Communication between the top of the traveler and the lower floors is effected by means of an electrically operated elevator as well as by wooden stairs encircling the elevator shaft. The motive power is supplied by a 15-hp. motor which gives a rope speed of 150 ft. per min. The controller is located in the car and is arranged for dynamic control. The motor is provided with a solenoid brake. Field telephones are also distributed over the bridge and traveler to facilitate communication with the different parts of the work.

The traveler, fully equipped, weighs approximately 1000 tons and cost in the neighborhood of $175,000. A duplicate traveler is being erected on the south shore, so that, next season, work can be proceeded with simultaneously on both sides of the river.

All the erection equipment was designed by the St. Lawrence Bridge Co., Ltd., Montreal, the contractors for the superstructure: Phelps Johnson, President; G. H. Duggan, Chief Engineer; George F. Porter, Engineer of Construction; W. B. Fortune, Superintendent of Erection; S. P. Mitchell, Consulting Engineer of Erection.

To Illustrate the Lasting Qualities of Cypress, when buried in the earth, the Southern Cypress Manufacturers' Association is sending out pieces of bored cypress logs laid for use as water pipe in New Orleans in 1798, or 116 years ago. One sample seen by a representative of this journal had an exterior diameter of about 12 in. and a 4-in. hole in the center of the heartwood. For about 1½ to 2 in. around the hole, the wood appeared to be as sound as when new. Outside this the wood showed a little decay and marked radial checks.

Factors in Grade Separation

In November, 1914, E. N. Layfield, Consulting Engineer, of Chicago, presented a report to the city and railway authorities of Houston, Tex., upon the local problem of grade-crossing elimination. Certain features of the report, dealing briefly with the Houston project and more extensively with the general subject of grade separation, are given below.

Grade Separation at Houston

There are 12 railways entering the city, having 50 miles of line, 300 miles of track and four stations within the city limits.

In the estimates of cost for Houston, the fill or embankment is taken at $1 per cu.yd. in place under the tracks. In the extensive work at Chicago a price of 50c. is generally used, but there is a vast supply of sand available from along the south shore of Lake Michigan, and this can be loaded and unloaded more cheaply than clay or ordinary earth filling. The cost of street excavation for lowering street grades is taken at 75c. per cu.yd., this work being expensive on account of interference with traffic and difficulty of drainage during the progress of the work. If this material could be used economically in the fill, the prices for both excavation and fill might be reduced. Concrete abutments and retaining walls are estimated at $10 per cu.yd., this price being arrived at after conference with the engineering departments of the city and the railways.

The bridge superstructures are assumed to be of steel at a cost of 4c. per lb. erected, to which is added the cost of covering with concrete and waterproofing. Under the conditions at Houston, reinforced-concrete structures would cost somewhat less and have advantages which are leading to their general use in work of this kind. The street paving is taken at $18 per lin.ft. of 65-ft. street, with brick paving on concrete base, concrete sidewalks and concrete combined curb and gutter. In most cases the damages to adjacent property would be small and would be covered by the 10% allowance for engineering and miscellaneous expense. Special allowances are made for such work as the elevation of the tracks through the Grand Central Station. The estimated cost of that portion of the work for which estimates are given is approximately $4,000,000. Other work within the city is suggested for the future, as a part of the general scheme, but on account of the remote date of its construction this is not included in the estimate.

Grade Separation Problems

Grades in Streets—In track elevation projects it is usual to allow depression of the streets at the crossings, so as to give a minimum height of raise of the tracks. This involves consideration of the approach grades on the streets. Easy grades mean longer and more expensive approaches and greater property damage, but, on the other hand, economy in cost must not be carried to the extreme of providing grades so steep as to affect the hauling of normal loads in the districts where heavy hauling is done. For horse traction, occasional short grades of 2 to 3% have very little effect on the loads, but steeper grades could be adopted if only modern motor-truck traction had to be considered.

The report states that in the Chicago track elevation

work about 1300 subways have been built with approaches of 3.5% for an average length of about 100 ft. on each side, the street depression averaging 3 or 4 ft. In some cases where the depression has been greater than this, and the approaches therefore longer, grades of 3% have been used. In several cities the grades are about the same, while in others they are 4 to 6%, or even much more in special cases. Many of the steeper grades, however, are in residence districts, where there is not much heavy hauling. Many of them also are in places where steeper grades previously existed on neighboring streets, so that there could be little object in incurring the expense of light grades in the approaches to subways or bridges.

The level portion of the street should extend far enough beyond the subway to permit loads of maximum height to clear the structure before starting up the grade. The grade and level portion should be connected by a vertical curve. It is usually sufficient to provide about 15 ft. from the face of the structure to the foot of the grade. This would be subject to variation according to local standards of vertical curves for streets, but in any case easy curves are desirable with heavy cars and heavy girder-rail track. This matter should be determined by means of large-scale diagrams showing the maximum height of load in different positions.

Headroom in Subways—In the earlier Chicago work, a headway of 12 ft. was adopted for subways without car tracks, and 12½ ft. for those with car tracks. The introduction of a new type of street car (about 1908) necessitated an increase to 13½ ft., even with a special trolley base on the car and a special trough for the trolley to run in. The height from the rail to the top of the board on which the trolley base rests is 11 ft. 9 in. Several of the older subways have been changed to give 13½ ft. headway, and all new ones are built with either 12 ft. or 13½ ft. These standards have been adopted in some cities near Chicago, while in others the headway is 13 ft. with no car tracks, about 14 ft. for city cars, and 15 or 16 ft. for interurban cars. At Kansas City, the ordinance provided for 14 ft. 2 in. headway in subways carrying car tracks, but the street railway company agreed to pay the additional cost of giving 14 ft. 8 in. headway, which it considered necessary for its equipment. The franchises for elevated railways in Chicago, New York, Brooklyn and Philadelphia require a minimum headway of 14 ft. at streets in which cars are run.

The increase in cost due to greater height would vary greatly, but for average conditions at Houston was taken at $2000 to $3000 per foot of headroom for a subway under two tracks. For a larger number of tracks the cost would be greater, but not in proportion to the number, as the cost of wing walls and approaches would not vary. In the estimates for the subways at Houston, the distance from the paving to the top of the rails has been taken as 17 ft., including the bridge floor, ballast and track. This dimension is susceptible of considerable variation without seriously affecting the general scheme.

Width of Subways—It is not necessary as a rule that a subway or viaduct should have the same clear width of roadway on sidewalk as on the adjacent portions of the street, as there is no occasion for vehicles to back up or stop at the curb or for pedestrians to cross each other's paths as in entering buildings or turning corners. This condition should be given consideration in economical design, but in some cases the full width may be required.

In Chicago, the street subways are in general 66 ft. wide between abutments, with curb lines 10 ft. from the walls. At the center of the subway a space about 3 ft. wide is taken for a line of columns and the wheel guards. This leaves about 21 ft. 6 in. for each roadway, which permits street cars and fast vehicles to pass slower vehicles moving in the same direction. This is rather more than is needed where there are no car tracks, but the width of subway is determined by the width of street, which is usually 66 ft. between property lines. For wider streets the 66-ft. subway width is maintained usually, except at boulevards.

The sidewalks are narrowed to 10 ft. to make up for the space occupied by the central row of columns, and their clear width is further reduced to about 8 ft. by a line of columns just inside the 10-ft. width.

Objection is made sometimes to rows of columns in the middle of the street and on the curb lines, but their use allows of a type of bridge which is more satisfactory and can be made more waterproof and less noisy, and the short spans permit the use of reinforced concrete for the superstructure. The center columns also divide the traffic going in opposite directions, and this is considered an advantage if the roadway on each side is wide enough for two vehicles.

Closing of Streets—It may be necessary in grade separation work to close some streets and readjust routes of street traffic to locations where it is possible to locate a subway or bridge. There is generally considerable opposition to this on the part of property owners affected, and such questions must be settled by negotiation and compromise.

Clearance Over Railway Tracks—While this question does not enter into consideration for the work now proposed at Houston, it is touched upon in the report on account of an existing viaduct over the tracks. In most of the older work of grade separation in Chicago (such as the viaducts built 25 to 30 years ago), the clearance was about 16 ft., and in very recent work it has been 17 or 18 ft. There is a strong tendency, however, to provide 21 or 22 ft. where possible, and many states have laws requiring such clearance, unless the Railway Commission or other competent authority permits a reduction in particular cases. The object of the greater clearance, of course, is to prevent injury to men standing on top of freight cars.

Vertical Curves on Railway Tracks—At points where change of grade occurs, vertical curves are necessary, but the conditions do not permit of following the practice employed in open country. In the latter case a rate of change not exceeding 0.1 or 0.2 ft. per 100-ft. station is often used for summits and 0.1 ft. (or less) for sags. At two crossings in Chicago, the rate of change in the vertical curve of the line passing under a bridge is about 0.6 ft. and 1.0 ft. In the layout of the work at Houston, the rate is taken at 0.2 ft. and 0.1 ft. per 100-ft. station at summits and sags, respectively.

The Longest Railway Tunnel in India is that piercing the Khojak Range between Quetta and Chaman, near the northwestern frontier, and having a length of 12,870 ft. The second longest tunnel, 3900 ft., is now being driven on a double-track cutoff between Thana and Diva. This pierces the Parsik Hill and reduces the distance 1¼ miles as compared with the present line which makes a detour around the hill.

The West End Sewage-Treatment Works, Hamilton, Ont.

By Bernard E. T. Ellis*

SYNOPSIS—The works will consist of an intake chamber, screens, grit chambers, two-story settling or Imhoff tanks, dosing and screen chambers, filter beds, sludge beds and a pump house. The general design of the works is outlined and the construction features described in detail.

In 1912, the author, who was then in the Main Drainage Department of Toronto, was engaged to design and carry out, under the direction of the City Engineer of Hamilton, the many different sewerage and sewage-disposal schemes of that rapidly growing city. After careful study, two-story or Imhoff sedimentation tanks with filtration were decided upon as the best method of treating the sewage from the residential district, known as the West End.

Character and Volume of Sewage

Hamilton is situated at the head of Lake Ontario, with a present population of over 100,000. The topography calls for two separate drainage areas, known as the East End and the West End, thus necessitating two main sewer outfalls. The present article is confined to the West End area only.

The town is sewered on the combined system, which causes the flow of sewage to fluctuate considerably, as well as to vary in strength. The West End drainage area was found to be 1225 acres. The calculations for the works were based upon this area being fully built upon (owing to the rapid growth of the city). Although weir readings at the outfall of the existing 6½-ft. circular West End trunk sewer gave the present daily dry-weather flow at approximately 3,000,000 Imp. gal., or 3,600,000 U. S. gal., it was deemed advisable to design the works

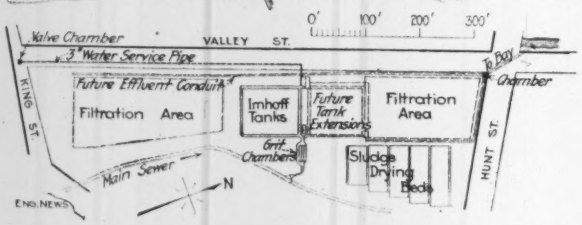


Fig. 1. General Plan of West End Sewage-Treatment Works, Hamilton, Ont.

with a capacity of 5,880,000 Imp. gal. per day, this being the total dry-weather flow from the drainage area. Samples of the sewage showed it to be a weak domestic one, discharged at the disposal site in a comparatively fresh condition, through the good gradients obtained on all the existing sewers in this district.

Treatment of Sewage

The works comprise intake chamber, screens, grit chambers, Imhoff tanks, dosing and fine-screen chambers, filter beds, sludge beds and a pump house. Fig. 1 shows the general layout of the works.

The intake chamber (Fig. 2), located on the 6-ft. main sewer leading to the disposal site, was designed as the storm-overflow chamber as well. An overflow weir with fixed angle irons for receiving boards provides for easily regulating the amount of stormwater to be treated at any time when the area is built up.

The weir is designed for anything above three times the dry-weather flow to pass over into the present sewer,

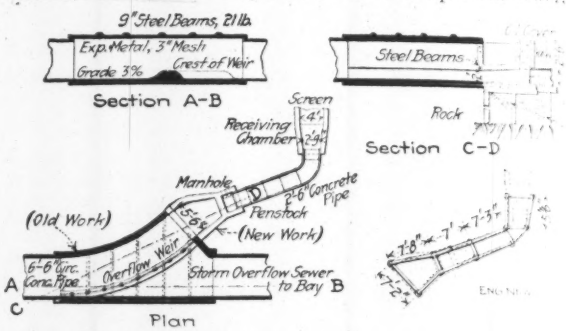


Fig. 2. Overflow Chamber and Connections between Main Sewer and Hamilton Sewage Works

which, when the works are in operation, will act as a storm-overflow sewer. At the end of this chamber an inspection manhole is constructed, with a gate for closing down the works at any time and passing the whole sewage over the weir into the marsh untreated.

The sewage passes through a fixed screen with bars or rods on ½-in. centers, placed at an angle of 45 deg. to the flow, and connecting with a 4-ft. open concrete conduit to the grit chambers. The grit chambers (Fig. 3) are built in series of three, with a 4-ft. bypass. Gates enable any individual part of the chambers or bypass to be operated separately.

These chambers were designed to have a minimum velocity of 1 ft. per sec., as they are intended only for the settlement of heavy mineral matter, such as sand, etc., and to avoid the removal of any putrescible organic matter. The chambers are emptied and cleansed by means of the 6-in. vitrified pipes, fitted with valves, shown in manhole (Fig. 2). The grit taken from these chambers will be utilized as the top filtering media for the sludge beds.

The sewage flows through a 3-ft. channel, with a junction laid out for future extensions, into the Imhoff tanks, which are in series of four (Figs. 1 and 4), over a weir and under scum boards into the upper compartments at an average velocity of 1.75 ft. per min. The heavy solids settle down into the sludge-digestion chamber, which is separated by means of concrete sludge aprons. Although these aprons overlap, they leave an 8-in. open-connection slot running the entire length of the tank for the sludge to pass through. These sludge-digestion chambers are subdivided by the baffle-walls into three equal compartments, and are designed for five to six months storage

*Now of Oborn & Ellis, Consulting Civil Engineers, Toronto and Hamilton, Ont. Late Engineer in charge of Main Drainage Works for the city of Hamilton.

capacity. The sludge is removed when required by means of an 8-in. cast-iron vertical pipe, with special 12-in. bell-mouth casting, resting on three-legged cast-iron supports, having its outlet into the main horizontal sludge discharge pipe. The inverts of pipes in division walls are 6 ft. below the mean water level of the tanks, thus allowing the sludge to flow by gravitation up the vertical sludge pipe, and into the sludge-discharge pipe to beds, which are laid at a minimum grade of 1 in 10.

The levels of the sludge beds and outlet points did not permit a grade for the gravitation of sludge, so it was gravitated as far as possible, then discharged into a small collecting well, where a pump house will be erected, and the sludge forced through the mains, feeding the beds by a low-set force pump electrically operated. The sludge beds (Fig. 5) are in series of five of varying length, of earthwork construction, well underdrained and located on the site so as to be well away from the public, should any smell (which is not anticipated) arise through improper decomposition.

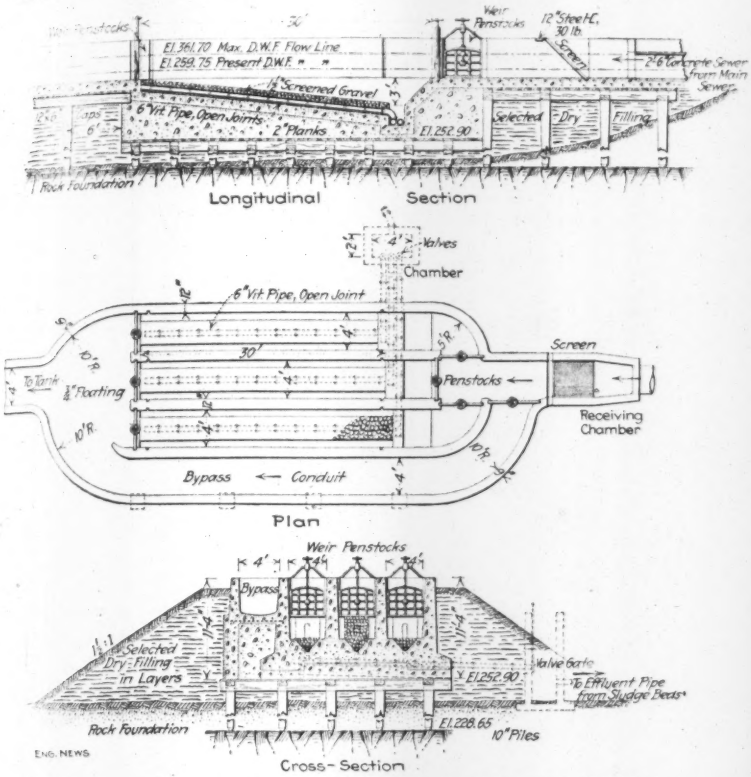


FIG. 3. PLAN AND SECTIONS OF GRIT CHAMBERS, HAMILTON SEWAGE WORKS

DETAILS OF CONSTRUCTION

The site purchased for the disposal works was in lowlying ground, the level being approximately 5 ft. above the mean water level of the marsh and outlet, which at times was very liable to flood, and at all seasons was saturated with water.

GRIT CHAMBERS—The intake chamber, feed conduits and grit chambers were constructed above ground level, on a pile grillage foundation. For safety, 12-in.

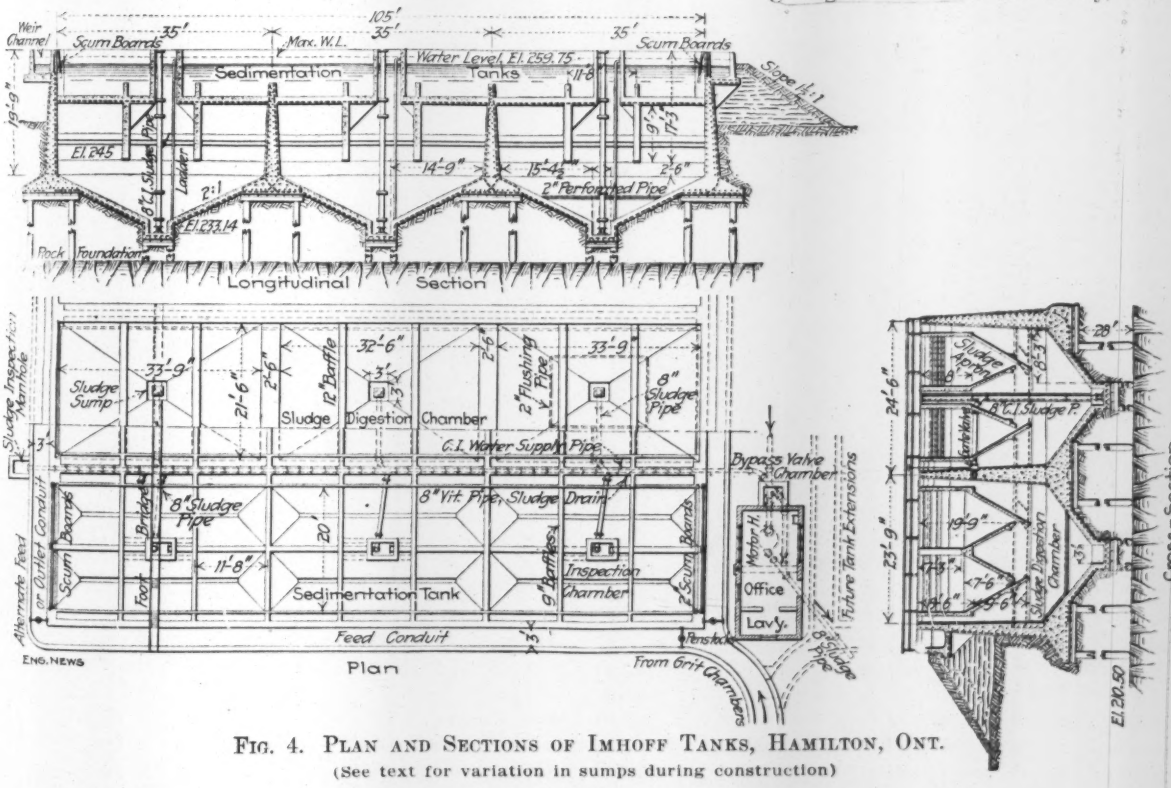


FIG. 4. PLAN AND SECTIONS OF IMHOFF TANKS, HAMILTON, ONT.
(See text for variation in sumps during construction)

piles, 35 ft. long, were used. These were driven with a drop hammer. A frame piledriver, operated with a steam-engine hoist, drove the piles at a cost of 18c. per lin.ft. through soft blue clay, with an occasional thin stratum of hardpan and gravel. These piles were capped and halved over intersections, doweled into the pile head, and jointed by a tension scarf joint with hardwood keys. The keys were cut longitudinally out of long-leaf Southern pine. The piles were decked with 2-in. pine planking, laid level to receive the remaining foundation work, rendered necessary through the rake of the chambers, which was filled up with hand-mixed concrete (1:10), at an average cost of $5.50 per cu.yd., including all labor, rough formwork and materials.

The main formwork for the chamber walls and bottoms was erected on falsework. All the struts, stringers, studs and sheeting were hung from the falsework. Studs 2x4 in., spaced 2½ ft. c. to c., were braced every 3 ft. with

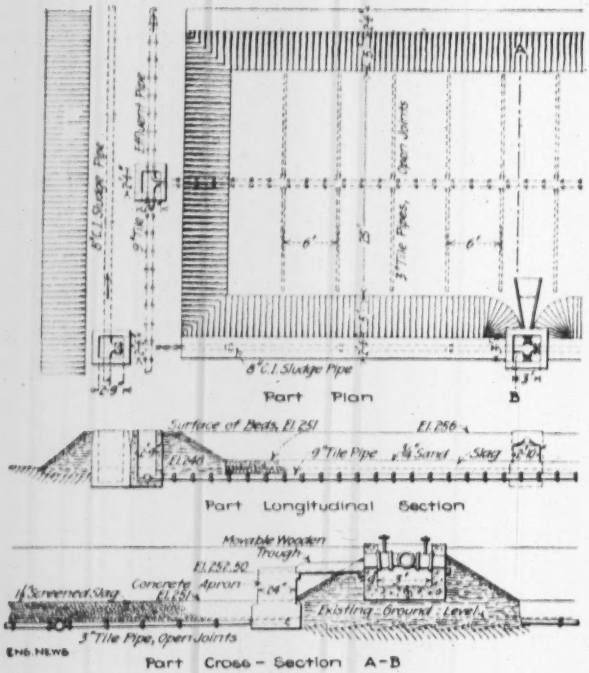


FIG. 5. SLUDGE-DRYING BEDS, HAMILTON, ONT.

4x4-in. struts and wedged. The 2-in. grooved-and-tongued sheeting was then nailed on to the formwork. A V-shaped bottom sump formwork was carried by the studs, and a framed box, to the required size and grade, was constructed for the outlet channel. The whole chamber was poured, as far as practicable, monolithic, with 1:6 concrete. This worked out, including all formwork, materials and labor, at approximately $8.50 per cu.yd. (this concrete was hand-mixed).

The surface, on stripping the formwork, was found to be in excellent shape and required very little attention, as regards filling or rendering. The formwork was exceptionally rigid, and the walls were true to line and dimensions. The radius formwork was a little more complicated and costly, but was accomplished with built-up inside and outside forms to the proper radii, held in position by raking shores off the existing work, and run at a total cost of approximately $10 per cu.yd.

The floors of the conduits and chamber bottoms were left in the rough state, for bonding purposes, and rendered to the required radii before drying operations were commenced by the usual screeding template, at a cost of 37c. per sq.yd.

IMHOFF TANKS—The excavation for the tanks was accomplished without timbering of any description. The sides of the excavation were simply sloped back and allowed to cave in, until their natural slope was reached, but owing to the treacherous nature of the ground, a great amount of extra excavation and filling in had to be contended with, as well as extra precautions taken to prevent accidents. The author thinks that, had the site been sheetpiled, the work of excavation would have been done quicker and cheaper as things turned out.

The *modus operandi* adopted to take out the dirt to the net size of 117½x109 ft., by 12 ft. deep to cellar level, was by the use of plow and hand scrapers. It was quite impossible to make much headway by this means, as well as extremely costly. The author installed the dump wagons, permanent way, turntables, etc., so arranged that the dump wagons were hauled up to a certain elevation by means of steel cable and steam hoist and then uncoupled. The full cars traveled by gravity on rails to the sludge-bed slopes, where the surplus earth was utilized for forming the embankments. The cost of this excavation varied considerably from time to time, as a great deal of water had to be contended with, and the spongy nature of the soil retarded the quick progress of filling the wagons. Taking a fair average, it cost about 95c. per cu.yd. to excavate, haul and dump on the sites selected.

The method adopted for the drainage of the works was by trenching below the level of all excavations as the work progressed, in all directions and as found necessary, and leading the same water into main carriers which connected to a sump at the lowest point of the excavated site. The water was then taken care of by means of a 6-in. steam-driven centrifugal pump, the excavated trench for effluent pipe line being the main outlet to the marsh. The excavation for the tank bottom was got out to the neat dimensions and trimmed off, but owing to the state of the soil, after standing a short while, with the action of the water and pumping, the sides of the slopes gradually washed away. In places, some 18 to 21 in. of concrete was required to bring the structure up to the true grade instead of the neat 12 in. excavated. The sump was excavated to allow for the necessary formwork. During concreting, a hanging box to the required sump dimensions was fastened firmly to the 4x4-in. studs, and the concrete poured under the bottom and both sides, in one operation, after the main ¾-in. rods for the slopes were placed in position.

A difficulty encountered in construction was forming and striking the miters. The plan, Fig. 4, shows a rectangular diminishing to a square sump, but the author, for simplicity, made the small sump in exact proportion to the large one, which worked out more satisfactory to all concerned in the actual construction.

The whole foundation work had to be carried on 12-in. piles, 28 ft. in length. These were driven in the same manner as those for the grit chambers, and cost to drive approximately 25c. per lin.ft. The higher price was due to the soft nature of the ground and the constant moving of the driver, through the piles being at 16-ft. centers.

There were four piles driven at 8-ft. centers under each divisional wall, with two intermediates, and two piles under the small sludge sump. All these piles were capped with 8½x7½-in. long-leaf Southern pine, halved and doweled at their intersection over each pile head to prevent movement.

The tank bottom was constructed of 1:6 concrete, and designed as a reinforced-concrete slab, with ⅜-in. round commercial steel rods, placed at various centers around the slopes and lapped. These were supported on ¾-in. steel rods, placed every 3 ft., well bonded into the concrete sump and main tank walls. The concrete was then run and kept monolithic as far as possible, and well tamped as the work advanced upward. Formwork was required and the sheeting was done in three to four board stages as the work advanced, to permit good access for consolidation of the concrete by tamping. Owing to the nature of the ground and to prevent the mud, etc., adhering to the reinforcing rods, an extra thin skin of concrete was run first. As soon as this became sufficiently hard the steel was set in position. By this means the rods were not only kept clean, but the placing of them was more accurately and permanently accomplished.

The tank bottom and the foundation of the walls were, as far as local conditions would allow, constructed monolithic. A dovetailed rough key was made about 1 ft. from the bottom of the wall for bonding the main cantilever tank walls, which were constructed as soon as the steel setting and framework had been accomplished.

The foundation to the tank walls had to be designed to carry its own weight, which meant the same being treated as a reinforced-concrete beam, having as its supports the main and intermediate grillage pile foundation. Steel rods ⅜ in. in diameter, 12 in. c. to c., lapped over the supports, were placed, and rough formwork for the outside slopes had to be used contrary to expectations. The tank walls were designed as cantilever walls, of sufficient strength to withstand the earth pressure when the tanks were empty, and were reinforced with ¾-in. vertical steel rods 6 in. c. to c., with every alternate one finishing about 2 ft. above the middle third.

The template rods, ⅜ in. in diameter, were placed on the inside face of the tank walls, 12 in. c. to c., and on the outside at the same centers for a distance of 4 ft. below the ground level, as the walls (which are backed with earth) below this depth will be beyond the action of the varying temperatures of this climate. These walls were carried up in 6-ft. stages all around the one tank, and an expansion dovetailed key joint was placed vertically over the center of the main pile foundations.

Square settings was the method adopted for supporting the formwork to all walls. Panels were built to the required batter, in sets of three, with 12-in. grooved-and-tongued pine sheeting dressed both sides. These were well soaked with water just before the concrete was placed, and the walls when stripped presented an excellent smooth surface, while no damage to the forms occurred. Dovetailed keys were left for all beams, baffle walls, sludge aprons and all internal concrete work, of sufficient depth to insure a good bond and connection of the reinforcement to the main ⅜-in. horizontal rods in the main walls. The concrete was prepared in a concrete mixer, capable of turning out ½ cu.yd. to the batch, and placed in a well elevated position to allow the concrete to run by gravity in wooden chutes to its respective location.

The concrete was mixed fairly moist to insure good tamping and flowing around the steel rods as the work proceeded, which accounted for the excellent hard and smooth surface obtained when the formwork was stripped.

All the rods were well keyed into the concrete, and at intersections were well wired with No. 16 gage annealed wire. The rods were supported by the erection of falsework, if occasion demanded. Wherever possible, long lengths were used for the main vertical wall rods, and by these methods they were kept in their proper position during pouring operations.

The cost of this concrete, including materials, setting steel and labor, was approximately $6.50 per cu.yd. The labor on the formwork cost an average of $2.25 per cu.yd., but as these prices were based on the first tank, the remainder should be considerably decreased on the completion of the works. The cost of the lumber is not included in these prices, as the panels and setting, with reasonable care, will be reused throughout the whole works, and will then, for accurate prices, have to be equally distributed.

The horizontal cast-iron sludge pipes and the Y-connections laid in the main divisional concrete walls were jointed on the surface, and pushed into position, packed up with blocks to the required grade, and then supported from the forms with No. 8 gage wire on 4x4-in. crosspieces. The packing was removed and the pipes brought to true grade by tightening or loosening the wire as required. The walls were then poured and well tamped with rich concrete, 1:1½:3, for a distance of 3 ft. (18 in. each way from the center line) around the pipe, to insure a strong and water-tight job. The cost of the labor for jointing and laying these pipes worked out at 25c. per lin.ft., without material.

The vertical and self-supporting cast-iron sludge pipes were flanged with turned faces and bolted together. In order to prevent clogging in the horizontal-flange sludge pipes, connecting the vertical and main pipes in the wall, instead of laying them level, they were laid at a grade of 1 in 36.

All the sludge pipes, wherever possible, were carried through the walls into inspection chambers for inspecting, rodding and cleansing purposes, and the ends were all fitted with a fire-hose connection for flushing from the city's water main. Another excellent, simple and cheap method of flushing the sludge pipes, which require extra attention for efficient working, was accomplished by connecting the main sludge-discharge pipe with a valve connection to the first-story sedimentation tank, which takes advantage of flushing with tank sewage under a 6-ft. head.

During the decomposition of sludge, many gases are given off. To minimize the passing of these gases from the lower to the upper compartment, good ventilation space was allowed between the two compartments. The sludge aprons well overlapped each other. Ample space to prevent clogging, was also provided in the sump round the bellmouth connection, and in addition to running a perforated lead water-pressure pipe around the slopes, a branch was taken off same to discharge in the mouth of the bell, to agitate the caked sludge at this important outlet.

The conduits were all struck to a given radii and carried on reinforced-concrete brackets, 10 ft. c. to c., and were so controlled by gates that it is possible to feed at

either end of the tanks, thus insuring a much more even distribution of sludge before cleansing operations in all compartments.

The concrete of all walls and floors designed to withstand pressure was built with 1:6 concrete. The price for material delivered on the site for 1 cu.yd. of concrete was $4.85. The labor of mixing and placing cost between 80 and 90c. per cu.yd. The steel reinforcement in position cost about 4c. per lb., including everything.

Sludge Beds—The sludge beds are constructed out of the surplus earth. The maiden soil was stripped off and the earth embankments acting as the main and dividing walls were taken down to a solid clay bottom and dumped into position from the wagons, as described in the tank excavation. Laborers spread and well tamped this material to the required slope of 2 to 1 at a cost of 15c. per cu.yd., allowances being made for final top dressing of 6 in. of black loam, which will be seeded with clover and grass seeds and made good after all settlement has taken place.

The insides of the beds were excavated to the required elevation and all the soft and boggy places removed and replaced with good stiff clay at a cost of 45c. per cu.yd. The underdrains will be laid with 3-in. unjointed vitrified pipes 6 ft. c. to c., at an angle of 90 degrees to the main 6-in. jointed vitrified pipe which discharges into the 9-in. temporary effluent pipe joining the main effluent pipe in the manhole. These filters have a minimum depth of 12 in. of graded gravel (the coarse being placed around the unjointed pipes) and the filtration surface being finished off with a layer of fine clean sand.

Under each discharging outlet a concrete apron was placed, so as to prevent the damage and displacement of the filtration material in times of operation. At the junction of the 9-in. main effluent pipe and main carrier from each separate bed an open concrete manhole is constructed which allows for easy inspection of the water from the drying beds which passes directly into the marsh. The sludge is discharged through 8-in. cast-iron pressure pipes into the different cast-iron branch feed pipes to each bed. The pipes are controlled by valves and the connection from the distributing chamber to the concrete apron is by means of movable wooden troughs.

These beds were calculated for sewage on the combined system and the area was based on approximately 550 sq.ft. per 1000 population. The estimated cost for forming slopes, seeding, etc., was 50c. per cu.yd.; laying of underdrains, including excavation and filling in with ballast, 20c. per lin.ft. for the 3-in. and 25c. for the 6-in. The 2-in. gravel cost $2 per cu.yd., delivered. The 8-in. cast-iron pipes delivered on the site cost $34.50 per ton; specials $3.25 per 100 lb., laid at 25c. per lin.ft. Concrete in all manholes and aprons was of class B, namely, 1 cement, 3 parts of sand, 5 parts broken stone, and was figured out at $6 per cu.yd. The sand cost $1.20 per cu.yd., delivered.

Filter Beds—After considerable thought it was decided to carry out only part of the general scheme for the present and do the tank construction work only and to leave all connections, etc., for the final treatment of the clarified tank effluent by filtration for the future as the effluent will discharge into a marsh which connects with Lake Ontario. The effluent outlet is a considerable distance from the lake and it was considered that for the present the effluent would be sufficiently oxidized before reaching the lake waters.

In General

At the present time, the works are well on the way to completion and will be rushed so that the complete plant may be in operation at an early date.

The contract bids from the plans and specifications varied from $160,000 to $63,000 for the work now under construction. This variation was due to the swampy nature of the ground and to the tanks' foundations being considerably below the lake water level. The work was finally let to the city, whose tender of $63,000 was accepted and work commenced in July, 1913. The ground, although being at times in bad shape, did not warrant the variations in prices submitted by the different contractors in Canada and in the States, as the scheme should now work out with careful management well below the estimated cost. If a first-class contractor with the proper plant had handled the work at the same figure, the writer is convinced that he would have made an excellent percentage on his money invested.

The author as engineer-in-charge supervised his own designs under the direction of the city engineer.

Lateral Strength of Hollow-Tile Walls; Tests at St. Louis

Several tests of walls built of hollow tile were recently made at St. Louis for the information of the city's Building Department. One of the novel purposes of the test was to determine both numerically and by comparison with a brick wall the lateral resistance of unreinforced tile walls built of Denison interlocking tile.

A Competitive Test

In the first test a brick wall laid in *lime mortar* was compared with a hollow-tile wall laid in *cement mortar*, both walls being subjected to horizontal pushing or bending forces of equal amount. Fig. 1 shows the arrangement of the test and also the I-beam cross-bracing put in as a means of relieving the brick wall of bending after it had failed, so that the test of the tile wall could be continued to higher load.

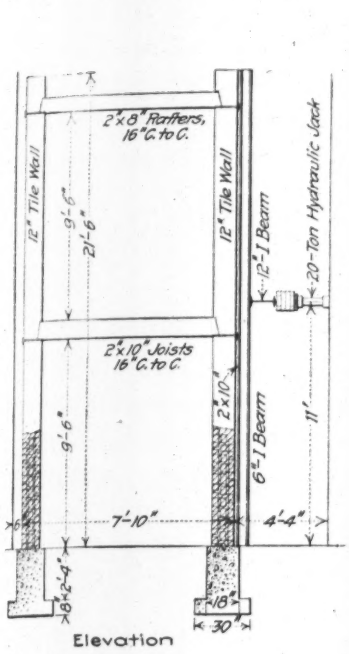
The walls were laid up early in April, 1914, and were tested on June 1, nearly two months old. Figs. 3 and 4 are views of the test. Fig. 4, in particular, is interesting, on account of the railway-car spring shown between the adjacent ends of the two jacks, this spring serving as dynamometer. Readings of the amount by which this spring was compressed gave a measure of the load exerted upon the walls, the spring having been previously calibrated at Washington University.

It is to be noted that the reinforced concrete-and-tile slab resting on top of the two walls was not connected to them by any positive bond, but only by the adhesion and friction of the bed joint of mortar. The test showed that this adhesion and friction were sufficient to hold the walls at the top in such a way as to bring the point of maximum bending practically at midheight of the wall.

At a load of 2500 lb. the brick wall failed; the horizontal mortar joint on the outside face, at about half height, suddenly opened for its full length. After putting on the I-beam frames to brace the brick wall, the

test was continued to determine the strength of the tile wall. The tile wall stood a load of 5000 lb. (just twice the strength of the brick wall), and then failed in similar manner.

This test was essentially a comparison of lime mortar and cement mortar, rather than a comparison of brick and tile. However, as common brick masonry is usually laid up in lime, while tile is always laid in cement, the test shows that the ordinary tile wall is stronger than the ordinary brick wall.



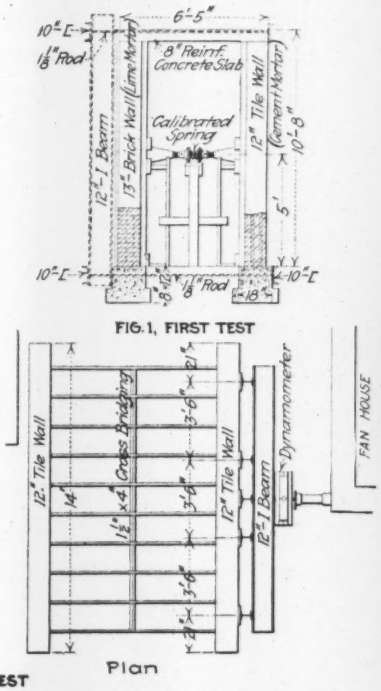


FIG. 1, FIRST TEST

FIG. 2, SECOND TEST

TEST ARRANGEMENTS, FIRST AND SECOND TESTS OF LATERAL STRENGTH OF TILE WALLS

WIND-PRESSURE TEST

A test whose arrangement is sketched in Fig. 2 was designed to represent a wind-pressure test. The two 12-in. walls 7 ft. 10 in. apart out to out, and 21½ ft. high, were connected by two tiers of floor joist, as shown. Pressure was applied by a jack against one side of the structure at a height of 11 ft. from the floor, or 8 in. above the top of the first-story floor joist. The pressure of the jack was measured by the pressing together of a rectangular frame 5x24 in., each of whose long sides was composed of four 2½x2½-in. steel bars set side by side.

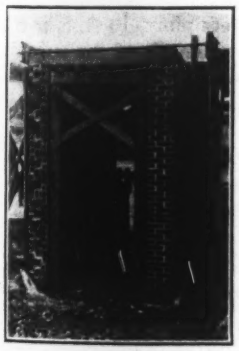


FIG. 3. VIEW OF FIRST TEST

The test was made at the age of 7½ weeks. The greatest pressure attained was 4440 lb. At this load horizontal cracks appeared at mortar joints near the base, on the inner face of the north wall and the outer face of the south wall. The load of 4440 lb. amounts to 14¾ lb. per sq.ft. which is equivalent to about 55 miles per hour.

STRENGTH OF TILE WALL UNDER VERTICAL LOAD

The vertical load-carrying capacity of tile wall was determined by loading two parallel 8-in. walls, each 4 ft. long by 38 in. high. Cantilever beams were built along the tops of these walls, and a concrete slab, 16x10 ft., constructed on the beams to carry the loading. Tested at the age of eight weeks, a total load of 139,000 (26,000 lb. per sq.ft. of gross area of wall bearing) was applied without producing signs of failure. The test had to be discontinued because the structure settled so much as to render it unsafe to carry the test further. The maximum load, considered uniform, was equal to about 700 lb. per sq.in. of *net horizontal section* of the vertical webs of the tile; but because the load had been applied somewhat one-sided to counteract the commencing settlement, it is estimated that the greatest load was about 900 lb. per sq.in. of web.

FIG. 4. JACKS AND GAGE-SPRING, FIRST TEST

These tests were made with Denison hollow tile (horizontal webs and interlocking construction), for the Laclede-Christy Clay Products Co., the St. Louis manufacturers of this tile. W. H. Schewe carried on the tests for the company, and Prof. J. L. Van Ornum directed the experimental and measurement work. The date of the tests was June 1 and 2, 1914.

Statistics of Fire Losses in Chicago dwellings of brick and of frame construction have been collected by Albert C. Cone, editor of the "American Lumberman," and were presented before the building committee of the Chicago City Council recently. These statistics showed that the total fire loss in dwellings alone is surprisingly small. If all the frame dwellings in Chicago, 90,000 in number, were to be replaced by buildings absolutely incombustible, and if all combustible materials were removed from their interiors, so that no fires whatever could possibly occur in these 90,000 dwellings, the total fire loss of Chicago would be reduced only 3½%. The Cone statistics further show that the average Chicago frame dwelling has a fire occur in it once every 54 years, in which fire damage of less than $100 is done. Only once in 2758 years does a fire in a frame dwelling communicate to an adjoining building, and only once in 4444 years will a fire occur that will totally destroy the building. Comparing the total fire loss on frame dwellings with their number, Mr. Cone finds that if the City of Chicago had paid in full the entire loss on every fire in frame buildings and their contents in 1913, and assessed the loss on each frame dwelling, the average assessment would have been only $2.11. On 30,000 brick dwellings in Chicago, if the fire loss in 1913 had been distributed in the same way, the assessment per dwelling would have been $2.93. Mr. Cone's statistics are worth the careful study of engineers responsible for the framing of fire laws and building ordinances.

Construction of the Barge Canal Crossing of Oak Orchard Creek

By Emile Low*

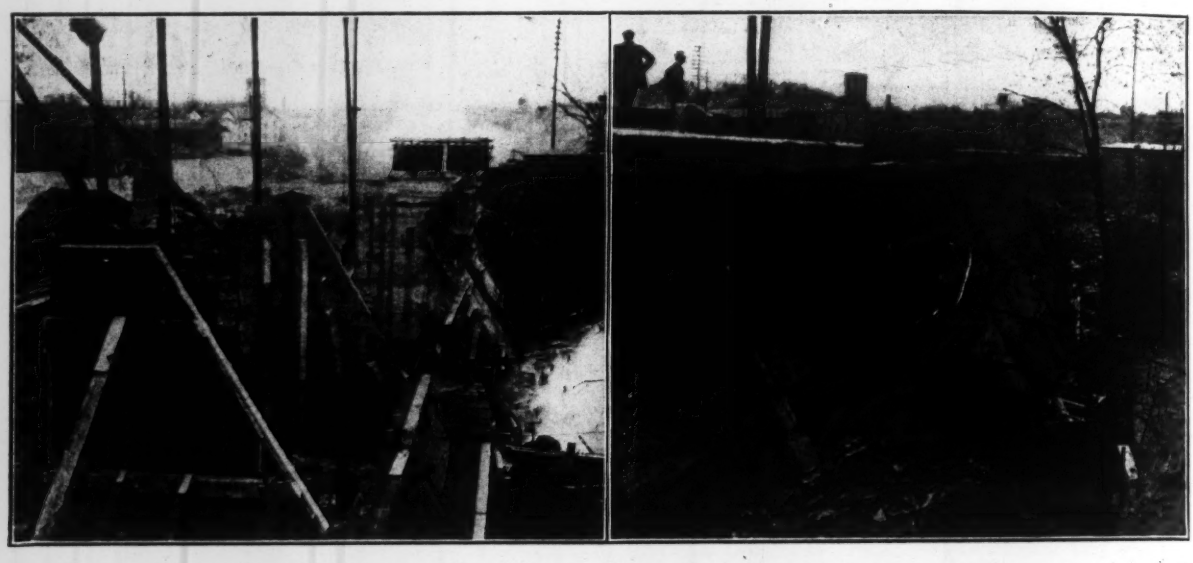
In Engineering News, July 31, 1913, p. 192, there was published an article by Noble E. Whitford, describing the design of the crossing to carry the New York State Barge Canal over the Oak Orchard Creek and Valley. The crossing consists of a great length of heavy earth and concrete retaining walls with a so called culvert carrying the canal across the creek. The work was let Mar. 18, 1913, to the Maryland Dredging & Contracting Co., of Baltimore, Md., at the contract price of $1,000,009.45. The article in question described in full the proposed plans of the contract, operations on which were begun in May, 1913.

This contract has been prosecuted with unwonted vigor; the amount done up to Nov., 1914, was $1,008,700, the contract being then practically completed. The largest amount of work was done during April, 1914, $136,760, and the average monthly amount about $80,000. The first work done was the excavation for the retaining wall north of the tow-path side of the old Erie Canal. As stated by Mr. Whitford, the amount of retaining wall on so short a contract is rather unusual. On the north side there is a continuous stretch of nearly 7000 lin.ft., while on the south side there are two stretches, together 4600 ft. long, or a total of 11,600 lin.ft., nearly 2¼ miles.

The aggregate used for the concrete was a natural mixture of sand and gravel pumped from the bed of the Niagara River and transported to the site of the work in canal boats via the old Erie Canal, the Barge Canal at Medina and also east and west being merely an enlargement of the present waterway, occupying almost absolutely the old alinement. The mixture used was one cubic yard of the natural material and 5½ bags of portland cement, being roughly 1 part cement, 1⅔ parts sand and 3⅓ parts gravel. In parts of the walls, some 5[illegible] cu.yd. of stone from the old aqueduct was used as pla[illegible] The largest quantity of concrete placed in one mont[illegible] April, 1914) was 10,600 cu.yd., the average being a[illegible] 7000 cu.yd.

In Mr. Whitford's article mention is made of [illegible] "overhang," to secure width for a tow path. This con[illegible]uction is well shown in Figs. 1 and 2, which also show [illegible] type of forms used to obtain this style of construc[illegible]. Immediately below the forms is the lower end of [illegible] new culvert.

Figs. 3-5 show the culvert carrying Oak Orchard Creek before and after the completion of the arch and retaining wall. As navigation had to be maintained during the open season, May 15-Nov. 15, no work could be done on tearing out the old aqueduct and building the new until after the latter date. It was not, however, until February, 1914, that the north end of the old aqueduct was removed to the lower arch and the south end to the level of the canal bottom, the entire removal being completed during March, 1914.



Figs. 1-2. The Sidewalls at the Oak Orchard Creek Crossing during and after Construction

The aqueduct sidewalls and skewbacks were built during April, 1914, during which month three of the reinforced-concrete arch rings were placed. The other two rings, as also the sidewalls, were finished in May, 1914, just before the opening of the navigation season. To support the arch centering, four concrete piers, 10 ft. c. to c., were built in the stream, the entire length of the culvert and parallel with the axis of the same. These piers were removed about three months after the rings had been placed.

The forms used for the typical retaining walls are shown in Fig. 1, the end pieces of heavy lumber, trapezoidal in form and conforming to the required section. The side forms were of smaller units and added as the placing of the concrete progressed. It is to be regretted that no architectural embellishment was added to the culvert opening. There is nothing but the blank, bare side wall, pierced by a segmental opening.

The concrete was run into drop buckets at the mixer, placed on flat cars and hauled to the site of the work

606 Ashland Ave., Buffalo, N. Y.

FIG. 3. OAK ORCHARD CREEK CULVERT UNDER CONSTRUCTION

by small locomotives—3-ft. gage—and then unloaded by derricks into the work. To provide for the overflow of excess water in the canal prism, a spillway or waste weir is provided in the south wall just west of the culvert. The top of this wall is at the elevation adopted for the ultimate water level, having a slight curved face to modify the fall of water. This excess water is used for electric generation, regulated by head gates in controlling works.

The excavation, which exceeds 500,000 cu.yd., was mainly done by two Bucyrus dragline excavators and two Marion steam shovels. Some excavation for the retaining walls was handled by derrick and hand. The excavation was well advanced in the spring of 1914, and

Operations of building concrete bridge abutments and erecting steel bridge superstructure was also continued during the summer of 1914, and all are practically completed.

The completion of contract No. 65, virtually completes the Barge Canal between the Tonawandas and the Genesee river, at Rochester, a distance of 80 miles. The remaining work is contract No. 83, at the Tonawandas, the connection between Tonawanda creek and Niagara river, and the connection of this creek with the present Buffalo level of the Erie canal. This section, however, is not being improved, except that portion at the western end, known as Black Rock harbor, which was done by the U. S. Government. So far, the Tonawanda-Rochester

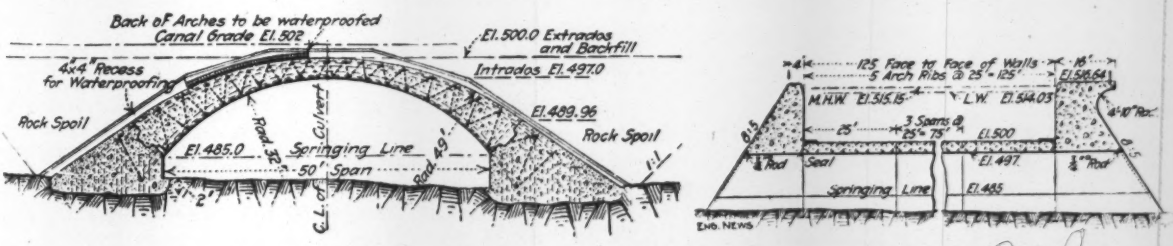


FIG. 4. DETAILS OF OAK ORCHARD CREEK CULVERT, MEDINA, N. Y.
(Reproduced from "Engineering News," July 31, 1913, p. 195)

following the opening of navigation and the filling of the canal prism with water, late in May, 1914, prism excavation was continued with a clamshell excavator upon a floating barge. Excavation was also made for wash walls located at the present elevation of the water surface.

section of the Barge Canal has cost over $15,000,000; this does not include engineering nor right-of-way or land damages. Including the cost of these latter items, contract No. 83, and a few miscellaneous items, as sheet-piling, electric installations, etc., the final or total cost will be about $19,000,000, or nearly $250,000 per mile.

FIG. 5. INSIDE THE OAK ORCHARD CREEK CROSSING OF THE NEW YORK STATE BARGE CANAL
(Culvert shown in foreground)

The original cost of the Erie canal, commenced July 4, 1817 and completed October 25, 1825, was $7,143,790, or a little less than $20,000 per mile, the canal being 363 miles long.

Garbage and Refuse Incinerator at Palo Alto, Calif.

By Neil H. McKay*

An incinerator with a daily capacity of 30 tons of mixed refuse was put in operation by the city of Palo Alto, Calif., on Jan. 7, 1914. The incinerator is of the Dundon high-temperature type, with a single cell, a level drying hearth, forced draft, a combustion and a supplementary combustion chamber, a boiler, and air and water heaters. Special machinery for handling (1) refuse, (2) dead animals and (3) ashes and clinkers is a feature of the plant.

The incinerator is housed in a reinforced-concrete building, located on flat land, at the outskirts of the city, close by the city pumping station. The incinerator is constructed of selected common brick, lined with 9 in. of firebrick and covered on the outside with No. 12 gage steel. The general arrangement of the furnace and its accessories is shown by the accompanying plan and section.

The refuse is discharged from the collecting wagons into a "Kangaroo Car," described later, which lifts it and automatically discharges it on to the charging floor. Here, after useful material has been removed, the refuse is thrown down the charging holes. It lands on the drying hearth, from which it is raked forward onto the grate bars. The products of combustion pass successively through the two combustion chambers, a 125-hp. Babcock & Wilcox boiler, two air heaters, a water heater, and finally to the 4x75-ft. No. 7 gage steel chimney, lined with brick to a height of 50 ft.

For forced draft, a 48-in. sirocco fan takes air from a purifier pipe over the feeding hoppers, passes it through the air heater already mentioned and delivers it beneath the grates, where it is automatically controlled by gates.

Elevating and Conveying Machinery

The land at the site being flat, elevating and conveying machinery was employed to a larger extent than is perhaps customary at incinerators.

Kangaroo Garbage and Refuse Elevating Car—An electrically operated car receives the refuse from the collecting wagons, runs up an inclined track and, as it reaches the level, automatically dumps its contents onto the charging floor. The body of the car is 7 ft. 9 in. by 8 ft. 2 in. in plan and has an average height of 4 ft. 10 in. The body is made from No. 8 steel and is riveted to a steel frame composed of angles and gusset plates. At the rear end of the car are two sets of wheels, one 16 in. and the other 30 in. in diameter. As the car is pulled up the inclined track by an 18-hp. motor, it runs on the smaller wheels. When it reaches the curve at the top the 30-in. wheels engage a second set of rails which elevates the rear end of the car and causes it to dump by gravity. A set of 12-in. sheaves attached to the rear axle of the car engages a counterweight when going over the curve. When the car dumps, this counterweight pulls the car back over the curve, after which it descends by gravity.

Dead Animals—These are handled from a cantilever boom.

Ash and Clinker Handling—Clinker and ashes are raked out from the furnace into manholes and onto a 16-in. helical conveyor located beneath the clinkering floor. The conveyor discharges into a crusher, also lo-

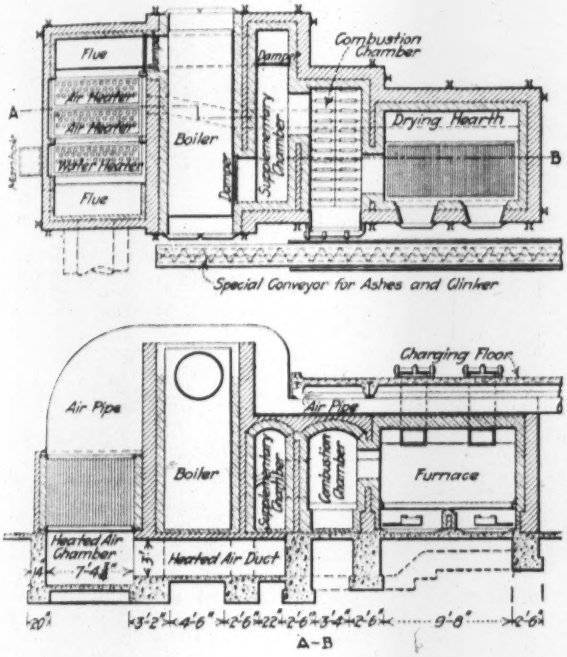
*Chief Engineer, Universal Engineering Co., 320 Market St., San Francisco, Calif.

cated beneath the floor. After passing through the crusher the material is lifted by a chain-and-bucket conveyor to a revolving screen, from which the graded material drops into elevated storage bins, provided with hoppers for loading it into wagons.

Operation and Tests

The amount of refuse to be burned is so small that the incinerator is operated only three days a week. Even with the frequent starting up thus required the combustible material in the refuse has been sufficient to kindle the fires and warm up the brick. Starting up with oil poured over a bed of refuse does not work well, as the fire simply runs over and scorches the surface of the material. No fuel has been purchased to start or to operate the furnace.

One man can easily take care of six tons of refuse per shift of eight hours. This includes weighing the refuse and the residue, keeping records, feeding and stoking the furnace and cleaning the floors.



Plan and Section of Refuse Incinerator, Palo Alto, Calif.

In the normal operation of the plant there is no nuisance from dust or smoke. A slight dust rises from the crusher when it is in operation, although it is believed that all joints are sealed as tightly as is possible. Such smoke as escapes from the stack is not objectionable and is almost imperceptible when the refuse is being consumed at a proper temperature.

During six days of the 30-day contract test, 75⅞ tons (151,750 lb.) of refuse were burned in 61 hr. This was at the rate of 1.24 tons per hr. and 82½ tons per sq.ft. of grate surface. The residue totaled 17,472 lb., or 11.2% of the amount charged into the furnace, divided as follows: Ash, 4%; clinker, 6%; cans, 1¼%.

The temperature in the combustion chamber during the test ranged from 1000° to 2300° F. and the average boiler pressure was 140 lb.

As already stated, the incinerator is being operated only three days a week, so figures for water evaporation are only approximate. During a test covering a week's operation an average of 11,700 lb. of refuse was burned per run and evaporated 3500 lb. of water, or 0.3 lb. of water per 1 lb. of refuse, after pressure was up. Just before each run the boiler was newly filled with water at 80° F. The fire was then started. In 1½ hr. a pressure of 140 lb. was secured and the steam was turned into the power-station header.

The average composition of the refuse as shown by samples taken on eight days in January, March, April and May, 1914, compared with the contract standard, is as follows:

	Pounds per Ton of Refuse.		
	Combustible	Non-combustible	Moisture
Actual average.....	404	553	1043
Contract standard....	460	540	1000

It will be seen that the refuse is lower in combustible matter and higher in moisture content than the contract standard.

The total operating cost per ton of mixed refuse is 46c. per ton, compared with the contract guarantee of 55c. This cost includes all work from the time the refuse is put onto the scales until the ash and clinker are in the bins. No reduction is made for value of the steam delivered to the power plant nor for the ash and clinker.

The cost of installing and housing the incinerator cannot be readily determined as the building also covers the city pumping and light plants, but the cost of the incinerator itself, including the stack and other accessories, was approximately $18,000.

The plant was built under the direction of the Board of Public Works of Palo Alto, with John F. Byxbee, Jr., as city engineer, by and after the design of the Universal Engineering Co., of San Francisco, Calif.

In the Tube Mills used in grinding cement at the Arrowrock Dam of the U. S. Reclamation Service, angular blocks of basaltic rock are being used instead of imported Danish pebbles. These blocks of basaltic rock are collected along the line of the Arrowrock Railroad and cost delivered at the mill only $1.50 to $2 per ton, whereas the imported Danish pebbles cost over $26 a ton. It is stated that the basaltic pebbles have less breakage, wear longer and prove more effective than the Danish pebbles previously used. The corners and edges of the rough basaltic blocks wear off quickly and the blocks assume a smooth ellipsoidal shape after running in the mill from 12 to 18 hours. The difficulty in obtaining the usual supply of foreign pebbles for tube mills has compelled the use of local stones in many other places with varying degrees of success.

Fires Due to Locomotive Sparks are a common source of trouble to the railways, and it is often a question as to how far the locomotive or the railway is really responsible. Some extensive tests as to the travel and effect of sparks were described at the annual meeting of the Indiana Engineering Society by Prof. L. W. Wallace, of Purdue University. Rows of pans were placed on the ground at various distances from the track, to catch the sparks; and cotton-wool, dry grass, etc., were used to determine the effect of sparks at different temperatures. The conclusions were that the greatest danger from locomotive sparks is within 50 ft. of the track; 65 to 70% of the total weight of sparks was caught within 45 ft., and 80 to 85% within 65 of the center of track. Of sparks hot enough to stick to paraffin 83% were caught within 45 ft. and 96% within 65 ft. of the track. The temperature of sparks reaching the ground is low, and not likely to be over 1200 to 1300° F. This may be enough to set fire to cotton wool, but higher temperatures are needed for dry grass and excelsior. The fire-carrying property of the sparks increases with their size; the largest caught was less than ⅜-in. diameter, while a vast majority were smaller than pin heads.

Concrete Arch Bridge at Saskatoon

SYNOPSIS—The new reinforced-concrete highway bridge over the Saskatchewan River at Saskatoon, Can., consists of nine arches, including four of 150 ft. span, which are said to be the largest arch spans in Canada. Each span has two arch ribs, with spandrel walls and columns, and the sidewalks are carried by cantilevers. The bridge is on a grade of 2.88%. An unusual factor in the design is the provision for a range of 140° in temperature. A special feature of the construction was the use of the pneumatic system of placing and delivering the concrete, with a maximum length of 1000 ft. for the delivery pipe.

Saskatoon is a growing city of 30,000 population, in the central portion of the province of Saskatchewan, Can., The Saskatchewan River is crossed by one highway bridge, built in 1907 (when the population was 1200). It has a floor width of 20 ft., besides one sidewalk carried on brackets. This bridge is inadequate to handle the heavy traffic and a much wider structure is necessary.

At a conference of the city officials and the Board of Highway Commissioners of the province, in June, 1912, a site for a new bridge was selected. This site offered various difficulties from an engineering standpoint. The elevation of the far side is some 50 ft. higher than the city side, and as the bridge crosses from a city park to the Provincial University grounds, the æsthetic treatment demanded careful consideration. The river is about 1100 ft. wide during high water.

The Board of Highway Commissioners designed bridges of two types: one having a steel superstructure on concrete piers, and the other consisting of a series of reinforced-concrete arches. The estimated cost of the two types varied by only about $6000, and the question became one of type rather than cost. A steel bridge with floor at so heavy a grade presented difficulties, and a concrete bridge was chosen because of better appearance and as best suiting the requirements.

The total length of the bridge and the retaining walls in its approaches is 1490 ft. It consists of one span each of 25 ft., 66 ft., 92 ft., 103 ft., and 136 ft.; four spans of 150-ft., and one irregular end arch span of 94 ft., having its abutment end some 40 ft. above its springing on the pier. The 150-ft. arches are notable as being longer in span than any of the same kind in Canada. The bridge is on a grade of 2.88% rising to the east. The total width of floor is 65 ft., including two 8-ft. sidewalks on cantilever brackets. Provision is made for a double-track street-car line between two 14-ft. roadways. The spans consist of two arch rings 16 ft. wide, 15 ft. apart. The floor system is supported by spandrel walls and columns, and is made up of beams and girders.

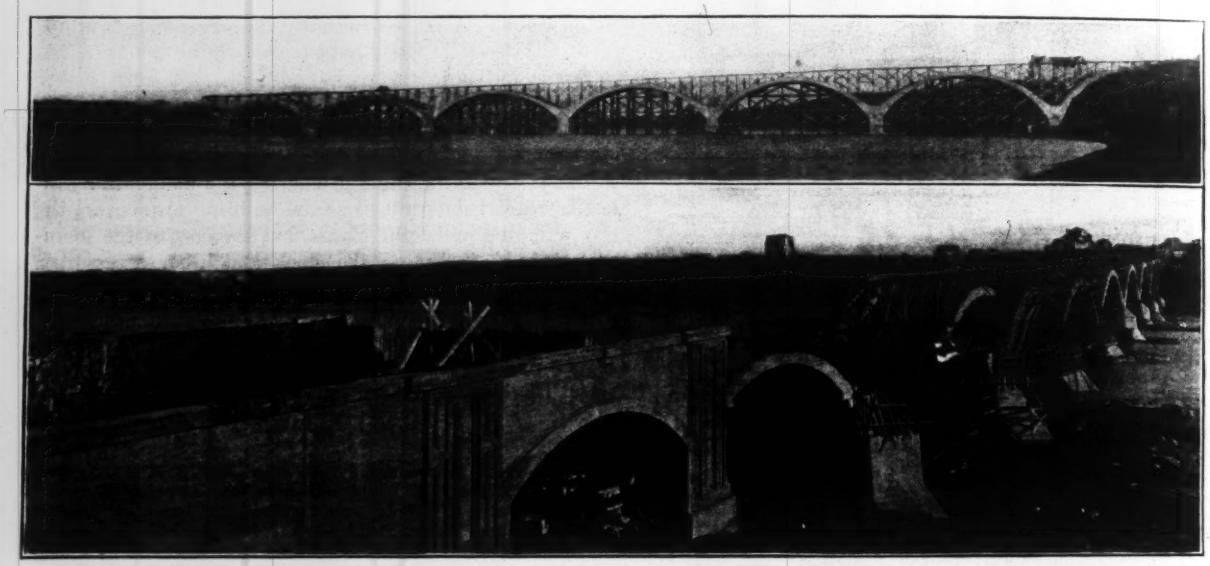


FIG. 1. REINFORCED-CONCRETE HIGHWAY BRIDGE ACROSS THE SASKATCHEWAN RIVER AT SASKATOON, SASK., CANADA

(The upper view is a general elevation of the work on Nov. 2, 1914, with the piers and arch rings completed. The lower view shows more detail of the design and construction. The trestle laid above the floor level carries the 8-in. pipe through which concrete was delivered by the pneumatic process.

By agreement the Board of Highway Commissioners was to carry out the work, the city paying 33% of the cost, and the city engineer being given opportunity to inspect the work and materials. Bids were opened July 15, 1913, and the contract was let to R. J. Lecky & Co., of Regina, as the lowest bidder. The price for the estimated quantities was $240,000. The cement and reinforcing steel are supplied by the Board, and bring the total cost to about $400,000.

The work was commenced Aug. 27, 1913, and continued through the fall and winter. In April, 1914, all the piers (except two river piers) were completed. The abutments and retaining walls (west side) were also done. Concrete for all except two piers was carried only to 8 ft. below the springing line. Considerable trouble was experienced with the third pier from the east end, and it was left with excavation only partly completed. For the river piers the coffer-dams consisted of a double row of

Wakefield sheet piling separated by a puddled-clay wall. A single row proved inadequate, and was the cause of the trouble in the third pier. This pier was attempted again in August, using a double row of sheet piling, and was successfully carried to completion.

The first two arches were poured in June, and the third in August. The last arch was poured Nov. 13. The completion of the arch rings ends the season's work. The floor system will not be built this winter. Fig. 1 shows the condition of the work in November, 1914. Fig. 2 is a general elevation, and Fig. 3 shows the structural design.

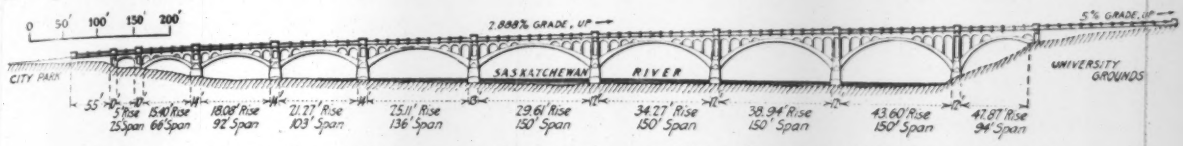

0 50' 100' 150' 200'
2.888% GRADE, UP
5% GRADE, UP
CITY PARK
SASKATCHEWAN RIVER
UNIVERSITY GROUNDS
55' 5' Rise 15.40' Rise 18.08' Rise 21.27' Rise 25.11' Rise 29.61' Rise 34.27' Rise 38.94' Rise 43.60' Rise 41.87' Rise
155' Span 66' Span 92' Span 103' Span 136' Span 150' Span 150' Span 150' Span 150' Span 94' Span

FIG. 2. GENERAL ELEVATION OF THE SASKATCHEWAN RIVER BRIDGE AT SASKATOON, CANADA
(Note the segmental arch at the right.)

LOADING

The loading for the floor is as follows: (1) On each track a concentrated load of 100-ton double-truck cars having a wheel spacing of 5, 15 and 5 ft., with 12½ tons per wheel; (2) on the remainder of the roadway a concentrated load of a 25-ton traction engine with wheels 8 ft. c. to c. and 10 ft. between axles, 66% of weight on rear wheels (30 in. wide); (3) on the sidewalks a uniform load of 150 lb. per sq.ft.

The loading for the arch rings includes a uniform load of 200 lb. per sq.ft. for the central 17 ft. of the bridge, 150 lb. for the remainder of the roadway and 150 lb. for the sidewalks.

The maximum allowable stresses are as follows: Concrete, 600 lb. per sq.in. for compression and 50 lb. for shear; steel, 13,000 lb. for tension and the compression to be not more than 15 times that of the concrete. In the calculation of temperature stresses the assumed range was from —50° to +90° F.

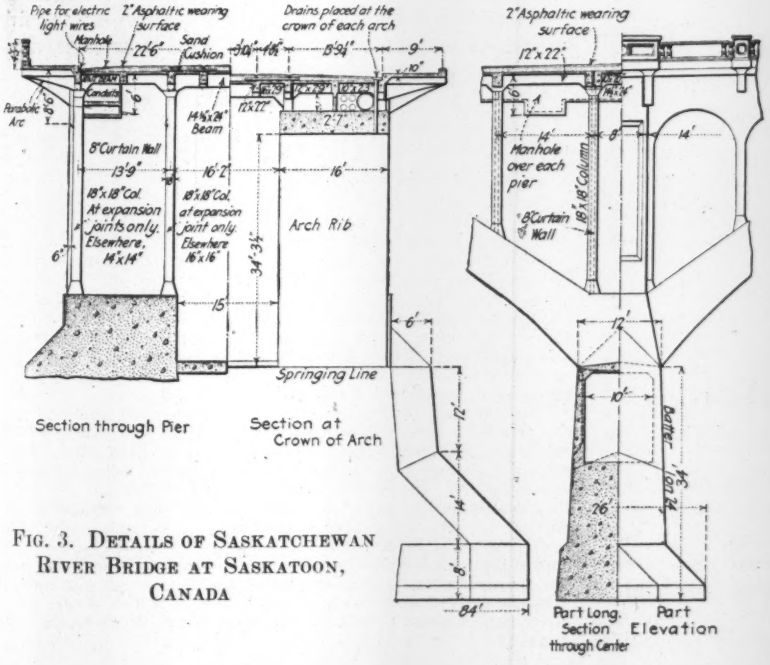


FIG. 3. DETAILS OF SASKATCHEWAN RIVER BRIDGE AT SASKATOON, CANADA

FOUNDATIONS

The subsoil is a very hard blue clay, almost a shale. As the excavations reached the required depth, test holes were bored some 18 ft. further and these indicated blue clay of the same general type. For loading tests a frame was used having a bearing surface a foot square, supporting a platform upon which known weights were applied. Readings for elevation were taken, extending over 48 hours. The experiments showed that the foundations would safely carry more than the maximum loading.

It was originally intended to place pre-molded concrete piles under the abutments and shore piers, but it was found that the subsoil was so hard that these piles could not be driven, nor were they necessary. Wood piles were used under retaining walls in approaches, and in part of the east abutment.

ARCH DESIGN

The arch rings were figured by the analytical method given by Turneaure & Maurer. The exceedingly high temperature variation assumed (—50° to +90° F.) added greatly to the difficulties of design, and in some cases the temperature stresses were greater than all other stresses combined. Considerable time and distraction were saved the computer by ruling the tables required in the calculations on tracing linen and using whiteprints made from them.

The grades to the floor system made all the arches different in rise, and separate designs had to be made for each of the ten arches. The large number of arches to be figured gave excellent practice to the computers, and the complete calculations for a trial design were done in as short a time as five hours.

CONCRETING

For the first arches the concrete was mixed in a batch mixer and handled by an elevator tower. Since August the concrete has been placed by a pneumatic concrete mixer, situated on the high east bank. This method (on the McMichael system) was adopted as being more economical. The apparatus is owned by the Pneumatic Concrete Placing Co., of Montreal, and was rented on a royalty payment per cubic yard of concrete deposited.

The mixer was of ½-yd. capacity. The number of batches per hour varied with the distance to point of delivery, being about 50 and 35 for distances of 375 and 1000 ft., respectively. A typical day's work was 500 cu.yd. in 17 hours. The air pressure was 110 lb. at the receiver. The delivery pipe was 8 in. diameter, with a

maximum length of 1000 ft. This pipe was laid along a trestle built above the centering at about the level of the floor, as shown in Fig. 1. It ended in a discharge box from which troughs were laid to the point of deposit.

In regard to the winter work, this was confined largely to placing coffer-dams and excavation. No concrete was poured in the cold months of January and February. One pier was poured in December, with temperatures ranging from 50 to 40° F. Two piers were poured in March, with temperatures from 15 to 48° F. For all this winter concreting the water was heated with a jet from a boiler. Another steam jet was used to heat the gravel when the temperature made this necessary.

The mixer was placed close to the work, and the mix was deposited either by an elevator and chutes or by wheelbarrows. Freshly laid concrete was covered with canvas for a few days. All concrete laid last winter has been entirely satisfactory.

A pit-run gravel was used for the piers, and a coarser washed gravel was added to this for the arches. The specifications provided for concrete of the following proportions, measured by volume, loose: (1) Arch rings, columns, girders and concrete deposited under water, 1:2:4 (stone) or 1:5 of sand and gravel combined; (2) abutments, piers, walls, aprons, etc., 1:3:5 or 1:7; (3) for the outer 4 in. of ice breakers on piers, 1:2:2 (stone). The concrete was spaded in the forms to flush the cement to the faces. After the removal of the forms, all surface cavities were pointed by filling with "dry mortar from which the surface film of cement must be removed before it sets."

Exposed surfaces of piers and arch rings were rubbed with carborundum brick to remove irregularities. The remaining exposed sufaces had the film of cement removed with stiff wire brushes and clean water. No cement wash was permitted. Plastering was permitted only on surfaces to be covered or backed with earth filling.

Engineers, Etc.

The bridge was designed by the engineering staff of the bridge branch of the Board of Highway Commissioners of Saskatchewan: A. P. Linton, Assistant Chief Engineer (at Regina, Sask.); Daniel B. Luten, of Indianapolis, Ind., acted in an advisory capacity. A. J. McPherson was Chairman of the Board until January, 1914, when he resigned and was succeeded by F. J. Robinson. Fred Saynor is Resident Engineer for the Board. R. J. Lecky is General Manager for R. J. Lecky & Co., the contractors, and L. O. Beam is Superintendent of Construction. Geo. T. Clark and G. D. Archibald have been successively City Engineers of Saskatoon during the construction of the bridge. For information and drawings we are indebted to Mr. Linton.

British Railway Accidents

By H. Raynar Wilson*

The past year has been a remarkable one for British railways, especially since the European War broke out at the end of July. Large bodies of troops and a vast amount of supplies have had to be conveyed with all the expedition possible, so the work has had to be done at high pressure. About 10% of the railway employees have joined the Navy or Army, but only a small proportion of these were engaged in train service, as the Government recognized that a depletion of the operating staff would imperil the working of the railways at a critical moment.

Notwithstanding the unusual demands on the railways, not a single passenger has been killed in a train accident since the war broke out. Equally remarkable is the record of the whole of the year 1914. Six passengers lost their lives in train accidents, but five of these were drowned in an unprecedented flood. This, however, is not so good as the years 1901 and 1908 as they had a perfectly clean sheet, and in 1909 there was only one passenger killed.

We, in England, are rather proud of our railway-accident record and that we have good reason may be judged from the following figures compiled from the Board of Trade returns.

Year	Number of Fatal Train Accidents	Number of Pass. Train Collisions	Number of Pass. Train Derailments	Number of Engine Miles Run to One Collision or Derailment
1904	3	83	54	.....
1905	4	66	55	.....
1906	5	77	75	.....
1907	6	118*	106	1,912,000
1908	Nil	121	94	1,963,000
1909	1	110	78	2,140,000
1910	4	88	61	2,840,000
1911	3	87	73	2,804,000
1912	4	90	63	2,636,000
1913	7	109	73	2,392,000

*The increase in the number of collisions and derailments in 1907 and afterward, as compared with previous years, was due to a change made in the system of reporting. For this reason the proportions as to engine mileage for years 1904-5-6 are not given.

In this connection it may be remarked that on Dec. 18 five short papers on cab-signals were read and discussed at the Institution of Mechanical Engineers, London. The writer took part in the discussion and said that he was in favor of cab-signals, because it would assist engineers in the performance of their arduous duties; but he thought it only right to point out that of the accidents reported upon by the Board of Trade in the five years, 1899 to 1903, inclusive, 47 were classed as being due to engineers over-running signals, while ten years later—in the five years 1909 to 1913—there were only 24 such cases, a reduction of practically 50%.

It must be regretfully added that the excellent record of 1914 was spoiled on the first day of 1915 when ten passengers were killed in a collision, due, it is to be feared, to an engineer ignoring his signals.

A Flat Long-Span Concrete Arch—A very flat concrete arch of long span was built during the past year over the Aare River at Olten, Switzerland. Its span is 269 ft. (82 m.) and its rise 30.4 ft. (9.27 m.), giving a ratio of span to rise of 8.8. The bridge is relatively narrow, being only 26 ft. wide between railings. The 16-ft. roadway is designed for 77 lb. per sq.ft. and a wagon of 13 tons weight, while the sidewalks are figured for 110 lb. per sq.ft.

The arch is three-hinged. Its curve was laid out to follow the pressure line. The width of barrel is 19.7 ft.; the ring thickness in 62-in. maximum (at quarter points), 48-in. minimum (at crown), and 52 in. at skewbacks. The maximum stress in the concrete is somewhat below 700 lb. per sq.in. The roadway, a 6-in. slab, is carried by four stringers supported directly on columns resting on the arch. The slab cantilevers out beyond the outer line of stringers to form the sidewalks. Expansion joints in the roadway are provided over the springing line and at the point where the roadway merges with the arch barrel. Load tests under a 16-ton steam roller gave deflections of ⅛ in. (Schweizerische Bauzeitung, Jan. 2, 1915).

*96 Hurlingham Road, London, S. W., England.

A Roadway Embankment Designed for Overflows; Philippine Islands*

An overflow section of roadway, to obviate the necessity of building excessively long bridges, has been introduced into highway engineering in the Philippine Islands. The Philippine rivers and streams under ordinary circumstances are not very formidable, but in certain seasons of the year, during and after the torrential rainstorms, they require quite considerable waterways. One way the problem has been met is by means of collapsible trestle bridges, as described in ENGINEERING NEWS, of Apr. 23, 1914.

In the case of the Gilbert bridge at the northern terminus of the Manila-North road, over the Laoag River, the southern approach to the bridge has been built in the form of an overflow roadway, which extends from the high-water bank to the foot of the trestle approach to the 7-span steel truss bridge. The truss bridge is 1120 ft. long, the trestle 324 ft., and the overflow road 1675 ft., so that the full width of the waterway is 3119 ft.

The "spillway," or overflow section, extends from the trestle approach to the San Nicolas shore, a distance of 510 m. An embankment was built to a level grade and with slopes of 1 on 1 and 1 on 5 for the upstream and downstream sides, respectively, and thoroughly rolled. Clay was mixed with the sand to give it binding power. This subgrade was surfaced with asphalted gravel, and both slopes were protected by 10-cm. layers of concrete, reinforced with barbed wire. A section of 40 lin.m., located in a depression near the trestle approach, was washed out on Aug. 21, 1914, by a moderate flood. Apparently the failure was due to excessive percolation through the sand and gravel stratum upon which the embankment was built. It is possible that the concrete protection on the upstream slope may have to be carried down, as a kind of core wall, to the blue clay which underlies the gravel. The spillway was constructed as an experiment, which was justified by its low cost, $17.50 per lin.m. If it proves successful, there are a number of other lowland rivers in the Philippines to which this method of treatment may be applied with economy.

The California State Highway Problems†

California is such an enormously large state in point of area that its state highway problems are in many instances different from those of the other states, whose road-building activity has been equally marked. The chief problem was to spend the $18,000,000 state road fund to most benefit the state as a whole.

The primary demand was for trunk line construction; for two roughly parallel lines, one through the coast counties and the other through the great interior valleys, the Sacramento and the San Joaquin, serving county seats and connecting centers of population by the most direct and practical routes. In the skeleton system of highways outlined, these constitute the backbone.

The secondary demand was for lateral road construction; to connect with the highway those county seats which are not directly served by either trunk line.

The trunk lines will constitute the great arteries of road traffic into which will flow the local traffic of every section, as well as the through traffic of the entire Pacific coast. The lateral roads, by location and purpose, are feeders only for the trunk lines. In importance, use, and logical sequence they constitute the subordinate part of the highway scheme.

The coast trunk line serves all of the county seats of the coast counties; the trunk line through the valleys serves all of the county seats of the valley counties, practically speaking. The problem of lateral roads is a problem by itself, in a location by itself. It is the problem of tying the eastern tier of counties, the mountain counties, to the valley trunk line. It consists almost entirely of mountain roads through sections largely undeveloped and sparsely settled, and connecting centers of population—county seats—of no great numerical importance.

The highway commission and its engineers in charge of each division have finished traveling 2000 miles by automobile, through these mountain counties, studying their location, needs and desires at first hand. These county seats, for the most part, lie to the east of the Sierras. Their connecting roads to the valley cross elevations of from 4500 to 7500 ft., and are now snow blocked for months. The problem is to build laterals to these points which will utilize the lowest passes through the mountains and be useable through the winter months.

*W. F. Root, District Engineer, in the October "Quarterly Bulletin" of the Philippine Bureau of Public Works.

†From the "California Highway Bulletin," January, 1915.

Necessary Qualities in an Engineer—It has always seemed to me that the nature of an engineer's work encouraged, if, indeed, it did not compel, mental honesty, and an attitude of mind toward truth naturally leading to the highest standards in applied morals. Nature's laws are mercilessly unalterable.

Closely associated with honesty in the makeup of an engineer is thoroughness. He must possess a power of analysis and a sort of genius for details. Building, as he does, for posterity, his structures to be tested by time, he must be careful, patient and thoroughgoing in the preparation of his plans.

Honesty and thoroughness are bound to produce self-reliance and a certain degree of boldness. But for such spirit of daring, Niagara had never seen a railroad suspension bridge, and none of the romances of engineering had been written.

This quality of boldness is close kin to another which characterizes the ideal engineer—initiative. Without it how few of his mighty works would have been wrought! While in no sense disregarding the lessons taught by experience, he will not be bound and fettered by the past, but will see old facts in new relations.

This is but another way of saying that the engineer must be a man of vision. He must have an eye for things invisible to most other men. How have the theories of so called cranks led to discoveries of untold benefit to mankind and applications of incalculable practical value?

Then, too, the engineer of the best type must be a man of faith. He must believe that the things which he does are really worth doing. He must be conscious of such law and order in nature as guarantee the stability of his structures.

It goes without saying that an engineer must have that comparatively rare gift called judgment. It is needed to regulate and control in all things lest honesty in dealing with men lead to unnecessarily brutal bluntness and a tactless way of telling truth; lest thoroughness in matters relatively unimportant be carried to such an extreme as to result in extravagant waste of time and a failure to economize effort and conserve force.

These seven—honesty, thoroughness, boldness, initiative, vision, faith, judgment—are as necessary in the evolution of an engineer as are the seven primary colors of the rainbow in the production of sunlight.—From the Presidential Address of Dr. Alfred Hume before the Engineering Association of the South, Dec. 28, 1914.

Future Operation of Long Electric Transmission Lines*

By R. A. Philip†

A comparison of two long transmission lines, recently completed by the Stone & Webster Engineering Corporation, shows how increased length modifies line phenomena and that a limit is approached where ordinary methods of operation must fail. One, Keokuk-St. Louis, 143 miles, comes within the range of ordinary methods; the other, Big Creek-Los Angeles, 240 miles, presents a different plan of operation indicating the tendency as new difficulties become more pronounced.

On long transmission lines, at no load the delivery voltage is invariably higher than that at the generating end. The rise increases as the square of line length—about 41% increase in length doubles the voltage rise. it is sufficiently accurate to say for present purp[illegible] As lines grow longer, the capacity reactance $\left(\frac{1}{2\pi f C}\right)$ [illegible] creases and the inductive reactance $(2\pi f L)$ [illegible] (where f = frequency, C = electrostatic capacit[illegible] L = magnetic inductance) with consequent increase [illegible] age rise. One particular length gives the relat[illegible] for resonance when the voltage may increase until ins[illegible] ators arc over or puncture or the line-charging current [illegible] great enough to burn out the generator.

Length of line which produces resonance depends on frequency alone; for given frequency there is a critical length of line where resonance occurs. This can be computed by transmission-line formulas, but there is a short-cut:

Electricity has the velocity of light—some 180,000 miles per sec. In a 50-cycle current, the "front end" of a cycle has $^1/_{50}$ sec. start over the rear end and will be 3600

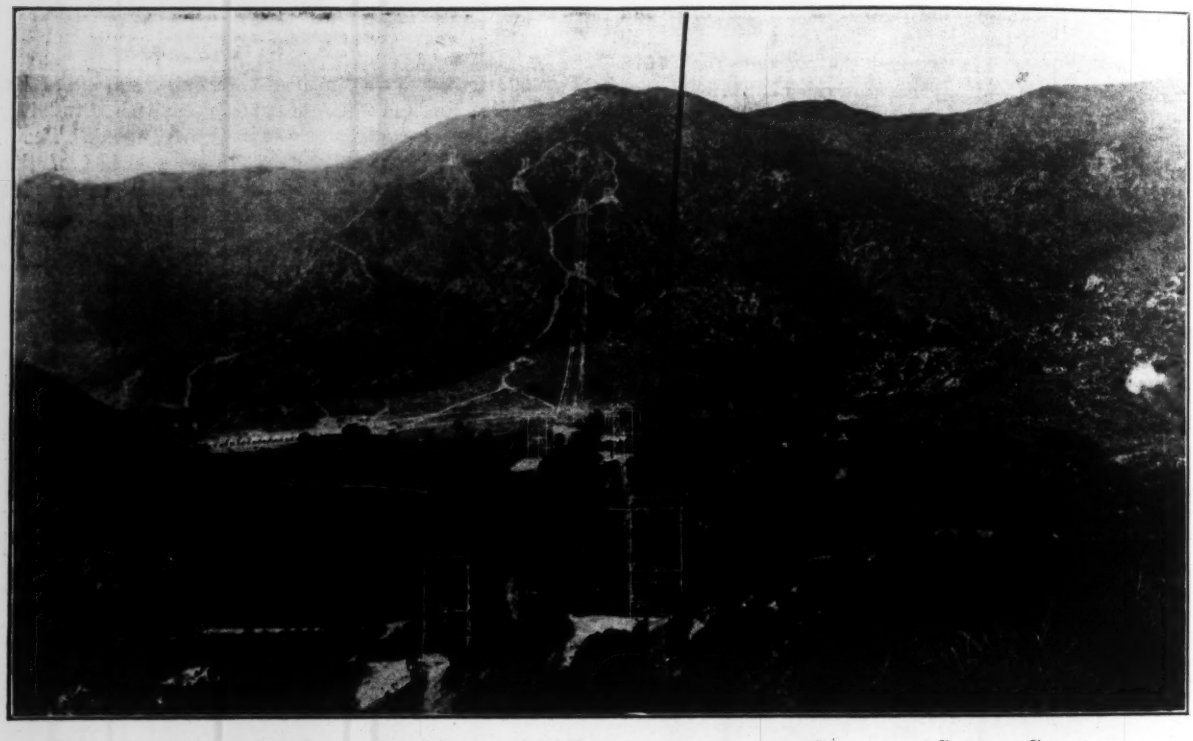


Fig. 1. Big Creek Transmission Line under Construction across Sycamore Cañon, California

This is true for short lines, but the amount of rise is negligible. Such a rise of voltage is a special case of what happens when a relatively small condenser is charged through an inductance; the voltage across the terminals rises to above that applied. The percentage rise obtained depends on the relative amount of capacity and inductance. One particular relation of capacity and inductance produces resonance and the rise becomes indefinitely great.

In a transmission line, the percentage rise of voltage depends entirely on length of line and frequency; the actual voltage used has no effect on percentage rise. The resistance, size and spacing of wires make no difference, miles away; that is, it has a natural wave length of 3600 miles. The length of line which produces resonance is one-fourth natural wave length—900 miles for 50 cycles and 1800 miles for 25 cycles.

Ordinary operating methods must fail on a line of critical length, for it is impracticable to charge the line when open. Critical length then furnishes a yardstick for determining whether a line is "long" or "short." When the critical length is so far off that voltage rise may be disregarded, then the line may be classed as "short"; while a line long enough to require precautions which are essential with critical length is a "long" one. On this basis, the Keokuk line is "short" and the Big Creek line is nearly, if not quite, "long."

For electrical purposes, the relative lengths of transmission lines are better stated as proportions of wave

*Based on an article in "Stone & Webster Public Service Journal," December, 1914.

†Electrical Engineer, Stone & Webster Engineering Corporation, Boston, Mass.

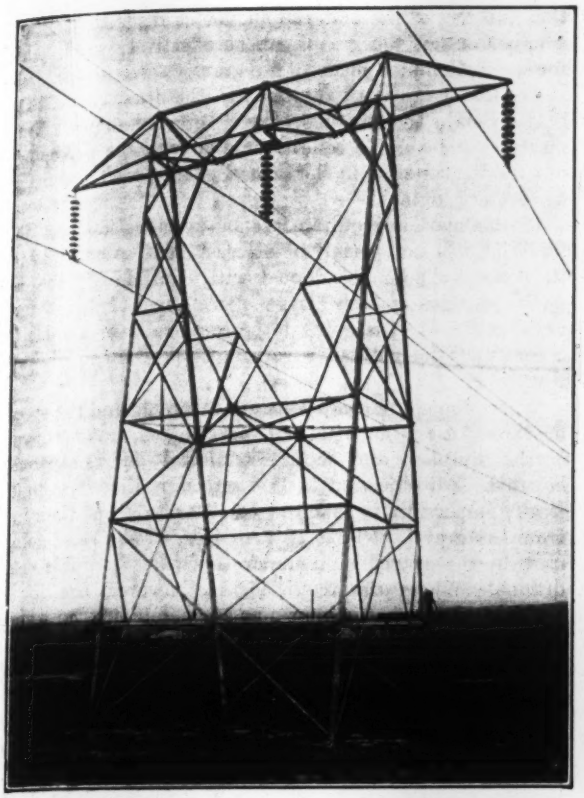


FIG. 2. STANDARD TOWER, BIG CREEK LINE

length. But wave length is an inconveniently large unit which may be considered divided into 360° for convenience. For 60 cycles, each 8.33 miles is 1°; for 25 cycles each 20 miles is 1°. On this basis, the 25-cycle Keokuk line is 7° long and the 50-cycle Big Creek 24°; critical length is 90°.

The relation between generated and delivered voltage is simple; taking delivered voltage as unity, the generated voltage is proportional to the cosine of the length of line in degrees. The cosine of 7° is 0.99 and of 24° is 0.91 and it follows that generated voltage is 99% of delivered voltage on the Keokuk line and 91% on Big Creek.

The Big Creek line differs from the Keokuk line, not in actually requiring new methods because of rise in voltage, but in providing methods (though for other reasons than voltage rise) which would make a line of critical length possible. The Big Creek line is a new departure in providing, at delivery end, "synchronous condensers" (synchronous motors running with no load) which are an integral part of the line design. Their principal function is to furnish leading current (maximum value of current cycle occurring ahead of maximum value of line-voltage cycle) thereby raising the delivery-end voltage when the line is loaded. This they can do with over-excited fields. But they have an almost equally important function of furnishing lagging current (maximum value of current cycle occurring after maximum value of line-voltage cycle). This they can do with under-excited fields (and they serve as inductance rather than capacity). Raising full-load and lowering no-load voltage make it possible to maintain a constant value of 150,000 volts at each end of the line for the whole range of load.

To see the tendency of operation for long lines, it is sufficient to consider the effect of the floating synchronous machines at no load. Then, half of the charging current of the line comes from the "condensers" and half from the generators. This is equivalent to having two separate lines of 12° length substituted for one of 24°; the voltage crest is at the middle and the generated and delivered voltages will both be about 98% the maximum. Thus the rise is cut down from 10% to 2%.

The length of the Big Creek line is not sufficient to make necessary control of voltage rise, but the radical nature of the step taken is apparent in the case of a line of critical length. Under the ordinary operating methods, the rise would be infinite and operation impossible. With the condenser at delivery end, the length of line is reduced from 90° to 45°; the cosine of 45° is 0.71 and the voltage at the line ends would be 71% that in the middle. The rise would be 41%—a large but not impossible amount. An additional synchronous machine at the middle would reduce the rise to 8%. A line of half a wave length, if so equipped at the ends only, would act as two lines of quarter-wave length—when this voltage would

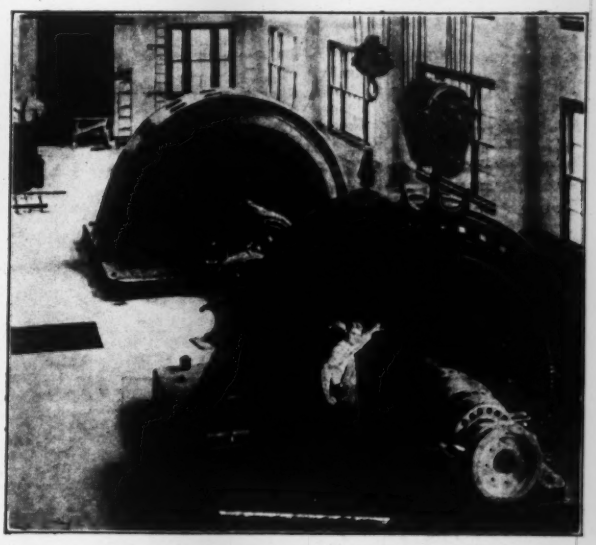


FIG. 3. SYNCHRONOUS CONDENSERS IN THE EAGLE ROCK SUBSTATION; BIG CREEK SYSTEM

build up indefinitely at the center unless restrained to 41% by a machine there or to 8% by further intermediate machines.

This use of reactance on a transmission line would be similar in purpose to the "loading coils" now extensively used on telephone lines—to neutralize the effect of distributed electrostatic capacity. The problem was met early on telephone lines on account of the higher frequencies and longer lines. For 500 cycles per second, an ordinary telephone frequency, the wave length is but 360 miles—and telephone lines over 2000 miles long are in use. The problems of "loading" telephone and power-transmission lines are not identical so that different solutions may be expected. The Big Creek line is probably the first systematically loaded power line and it indicates that power-line loading will diverge from telephone practice from the start. Telephone lines are loaded with fixed inductance while power lines will carry synchronous machines acting as inductance at no loads and condensers at full load.

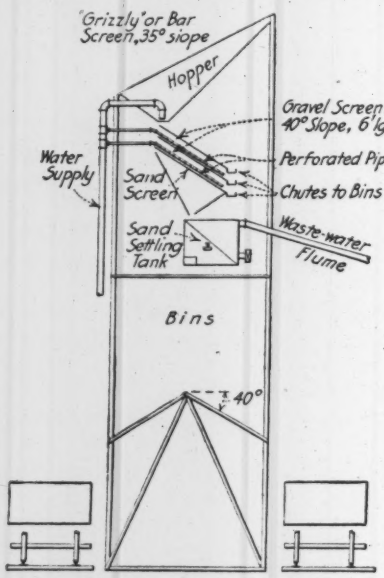
Notes on Screens for Gravel Washing and Screening

By W. H. Wilms*

Since the writer's series of articles on the operation of sand and gravel plants appeared in Engineering News, Nov. 5, 12 and 19, 1914, he has received numerous inquiries regarding the relative merits of gravity and revolving screens. In an effort to answer these many inquiries the writer has prepared the following:

The method of screening and type, size and arrangement of screens depend very largely upon the character of the pit-run material, the grades of material it is intended to produce and whether or not the material is to be dry screened or screened with water.

Dry Screening—It would seem hardly necessary to call attention to the fact that it is practically impossible to screen dry material by means of gravity screens. The revolving cylindrical screen is the only type of screen suitable for dry screening and its effectiveness will largely depend upon the amount of moisture in the material and the percentage of sand in the gravel.



Sketch Showing Arrangement of Gravity Screens

With dry material not containing an excessive amount of sand, fairly good results may be obtained. If the material is moist or wet and the percentage of sand high, however, dry screening will prove anything but satisfactory. Wet and rainy weather also has its effect upon dry screening; in many cases making it impossible to screen at all during such weather.

Gravity Screens—Where the material is excavated from a wet pit, such as rivers and creeks, and reasonably clean, a very fair degree of screening can be obtained with the simple inclined gravity screen, provided plenty of water is used on the screen plates.

Gravel taken from below water is apt to be quite clean and free from that hard, argillaceous matter so often found firmly cemented to the gravel of dry deposits. This is not always the case, however, and an examination and test of the material should be made to ascertain whether or not the gravel can be effectively washed before any attempt is made to use gravity screens.

To produce the best results with the gravity screen the gravel should be composed of well rounded stones. Even under such favorable conditions, however, the percentage of oversize material in the several grades produced is apt to be quite high.

If the market requirements or specifications for the material will not permit of at least 10% oversize, gravity screens should be adopted with caution. If the deposit contains a very large percentage of long, flat, angular stones, it is going to be practically impossible to screen material without a very large percentage of oversize.

Where the above conditions are favorable and the specifications for the material will permit, the gravity screen is the simplest and most economical one that could be used. An objection to this screen is that it is practically impossible to take out or separate all of the sand from the gravel, at least 10% to 15% of the sand going in with the gravel, even under the most favorable conditions. Where the requirements, however, are for a road gravel or what is known as a concrete mix, in which a certain percentage of sand is required, this objection does not obtain, and a very fair grade of such material can be produced with this type of screen.

The accompanying sketch shows a very effective gravity screen arrangement used in connection with a dragline cableway excavator. The material is dumped by the excavator directly upon the "grizzly" or bar screen, the material rejected by this screen going to the crusher or waste pile. The material going through the bar spacings is fed directly from the hopper to the screens.

While the usual practice is to discharge the entire water supply for washing directly upon the material in the hopper, much better results have been accomplished by delivering at least one-half of the supply directly upon the screens by means of perforated pipes. The purpose should be to keep the water with the material as long as possible, for the moment the water leaves it, screening ceases, the material simply sliding over the screen plates.

In sliding over gravity screens, the material acquires a velocity in a very short time that prevents it from going through the perforations. For this reason only the first 5 or 6 ft. of the screen is effective. Nothing is accomplished, therefore, in using screens longer than 6 ft.

It is advisable to make the screens in sections so as to permit of easy handling. The screens should also be at least 2 ft. apart so that repairs and renewals of any of the sections can be easily and quickly made without disturbing the other screens.

The initial screen should be a bar screen. The sizing screens should be of either heavy, square-mesh wire or perforated metal. If perforated metal is used, the perforations should be spaced somewhat closer together than is ordinarily the practice in a revolving screen plate.

Sand Screens—Gravity Type—A great deal of trouble is usually experienced with the sand screens, the main difficulty being to prevent the screen from clogging. The shape of the sand grains, whether round or long and angular, shape and size of screen perforations, manner of applying water to the screen, amount of water and inclination of the screen, all have their effect upon the efficiency of the screen.

*Manager of the Universal Sand & Gravel Co., Brooklyn, Morgan County, Ind.

If the sand grains are round, such as are most river sands, it is generally advisable to use a slotted perforated plate for the sand screen, as with round or square perforations the screen is very likely to clog up. If the grains are long and angular, however, such as are a great many bank sands, it is generally advisable to use a round perforation in steel plate or a wire mesh screen. For this purpose No. 11 wire for the coarse and No. 16 wire for the fine sand screen have proven effective.

Amount of Water Required—Gravity Screens—The amount of water required varies, of course, with the amount of impurities in the gravel, but where this method of screening can be used at all a supply of at least 1½ gal per min. per cu.yd. of material screened per day should prove effective. A larger amount of water is required with the gravity screen than with the revolving screen; but inasmuch as an ample water-supply at comparatively low cost is generally assured where wet material is being handled, this feature is of no particular importance.

Settling Tanks—The sand is separated from the dirty water by means of settling tanks which permit the dirty water to flow off, the sand discharging itself through an opening at the bottom. The subject of settling tanks, their design and operation, has been treated by the writer somewhat at length in an article published in Engineering News of Nov. 19, 1914, to which the reader is referred. The practice of spouting the sand and dirty water to large open storage basins and permitting the dirty water to escape by flowing through and over the sand results in a very dirty sand, the action being similar to that of a sand filter.

The writer would not recommend the use of gravity screens for washing and screening bank or dry material, as he has yet to see a gravel from a dry deposit that could be effectively washed and screened by means of gravity screens.

Revolving Screens—Where the clay, loam or other impurities in the gravel can be easily washed out, any one of the several types of revolving screens will produce satisfactory results, so far as screening and washing of the material is concerned.

If the material is very dirty, however, and the gravel covered with a hard film of dirt, effective washing is impossible in any screen. In such cases some form of preliminary washing and scrubbing is absolutely necessary before the material is permitted to enter the screens.

The ordinary cylindrical screen with a steel cylinder extension at the head, or feeding end, of the screen for effecting this preliminary washing has proved a very efficient and economical unit for the screening and washing of dirty material. Lengthwise of the inside of the washing cylinder are lifting blades, which by the repeated lifting and dropping of the material in a bath of water, loosens and scours off the clinging clay, loam or other impurities. One of the most effective of these washing and screening units, of which there are many in successful operation, is manufactured by the Webster Manufacturing Co., Tiffin, Ohio.

While the Gilbert type of revolving screen is a very effective screen for the screening and washing of all but extremely dirty gravel, the main objection to this screen is the comparatively large head-room or clearance required for their installation. For plants of moderate capacity, producing several grades of material, where all the head-room possible is desired for bin storage, the writer would recommend a cylindrical screen. Where these conditions do not obtain, the Gilbert conical screen or the inclined conical screen (Dull screen) are equally satisfactory.

Speed of Screens—For the most effective screening of gravel, revolving screens should have a peripheral speed of about 140 ft. per min. The speed of the sand screens should be from 20 to 35 ft. per min. greater.

As to the method of applying water to the screens, amount of water, size and shape of screen perforations, grades of chutes, between screens, preparation of sand, etc., the writer would refer the reader to his series of articles on the operation of sand and gravel washing and screening plants in Engineering News of Nov. 5, 12 and 19, 1914.

Effect of Illuminating Gas on Asphalt Pavements*

Conclusions from laboratory tests show (a) that illuminating gas without agitation rapidly liquefies asphalt cement and refined asphalt and destroys its value as a cementing medium and (b) that illuminating gas not only attacks but combines with the asphalt, increasing its weight.

The leaking gas naturally follows the lines of least resistance, which may be either in a nearly vertical line and show the results almost immediately above the leak or—what is extremely hard to find—may follow a long distance through a vein of porous earth or along the space formed by some old settled trench and reach the pavement surface a long distance from the leak. In such cases the pavement is generally affected over a large area, because the earth has become quite generally saturated with the gas, which gradually works up to the pavement surface.

Frequently, if not generally, the first indication of leak in the gas main, where the street has a bituminous pavement, is the effect on the pavement. The visible effect of leaking gas on a bituminous pavement is a serious "shifting" or "rolling" of the pavement in its softened condition, accompanied by a breaking up of the surface into a "cackled" appearance like an alligator's back.

Generally when this condition is noticed, a perceptible odor of gas will be found in the pavement surface, but sometimes the leak may have been repaired or the gas taken another course and the gas escaped so that its odor cannot be detected, yet the pavement is left in a seriously damaged condition. On the other hand, under certain subsoil conditions, the earth below the pavement may retain the escaped gas and continue to have its damaging effect for months, if not years, after the gas main has been repaired, and the cause of the trouble probably removed.

In such cases, before making repairs to the pavement, its entire surface over the main and where the surface shows the effect of gas should be removed and the gas main should be thoroughly repaired (renewed if necessary). After the leaks are repaired, vents or openings at least 1 ft. square, extending from the surface to the level of the gas main, should be left open for two or three weeks or longer, if there is still any odor of gas, and the openings then refilled and *thoroughly tamped.*

*Extracts from the paper of George C. Warren, President of Warren Brothers Co., Boston, Mass., read at the annual convention of the American Society of Municipal Improvements, Boston, Mass., 1914.

Field and Office

A Concreting Plant with a Braced Double Tower

In distributing concrete by spouts in building construction, the usual plan is to erect separate towers, each with its set of guys and having its elevator and discharge hopper. A novel departure, the use of a pair of towers connected by timber trusses to form a single structure, was employed in the construction of the eight-story warehouse building for Montgomery Ward & Co. The

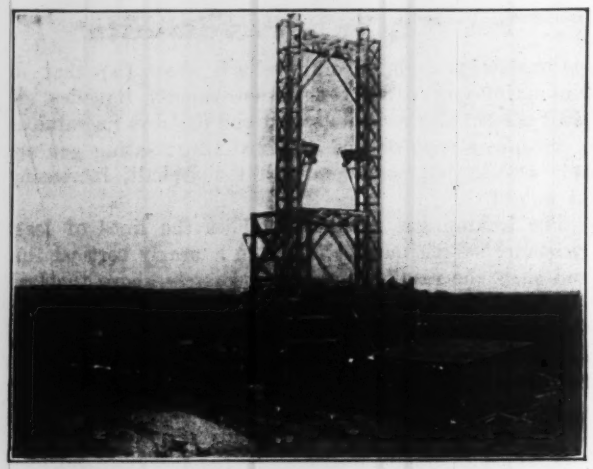


FIG. 1. DOUBLE ELEVATOR TOWER WITH THREE SPOUTS, USED IN CONCRETING THE BUILDING OF THE MONTGOMERY WARD CO., AT KANSAS CITY, MO.
(Wells Bros. Co., Chicago, Contractors)

Wells Brothers Co., of Chicago and Kansas City, had the contract for the work.

The double tower is shown in Fig. 1, and the general layout of the plant in Fig. 2. The use of this tower was due to special conditions encountered, as indicated by the plan. The quantity of material to be handled (some 35,000 cu.yd.) and the time in which it had to be placed would ordinarily have required three mixers and towers in order to keep the work going continuously. The layout was such, however, that it was impossible to devise a practical plan for the use of three towers. On the other hand it was absolutely necessary to provide for the delivery of the concrete at three definite points, in order to secure the minimum distance for wheeling the concrete. Under these conditions the double-tower three-spout plan was developed.

The building is U-shaped in plan (Fig. 1), the open space being intended to accommodate tracks connecting with the Kansas City Terminal Ry. As there were no facilities for team delivery to the site, it was necessary to utilize this space for material tracks and the construction plant. The contractor therefore installed four tracks. The two outer tracks, adjoining a dock or platform which ran around the inside of the "U", were used for the loaded cars and extended the full length of the dock past the towers, storage bins and cement house. Between these were two other tracks, connected with them at a point immediately north of the plant. These inside tracks were used for empty cars.

At the extreme south end of the space was the cement house, built so as to just clear a box car. This had doors in the sides to permit of unloading the cement direct from the cars into the house, and doors in the north end to permit of cement being carried directly to the mixer without interfering with the unloading of the cars. The east track was used for cars of cement and sand. The stone required a larger number of cars, and these were handled on the west track.

Immediately north of the cement house were the elevator towers, so located as to clear cars on both tracks. Immediately inside of these were placed the mixers, the tops of their hoppers being flush with the platform and floor of the cement house. Toward the center of the space and behind these mixers was the operating platform conveniently located so that one man on each platform could operate the water valve and the levers for discharging material from the bins and dumping the concrete from the mixers into the tower buckets.

The storage bins were built immediately over the mixers, leaving headroom for the operators and filling the entire space between the towers. The towers were made as small as was practicable to accommodate a 1-yd.

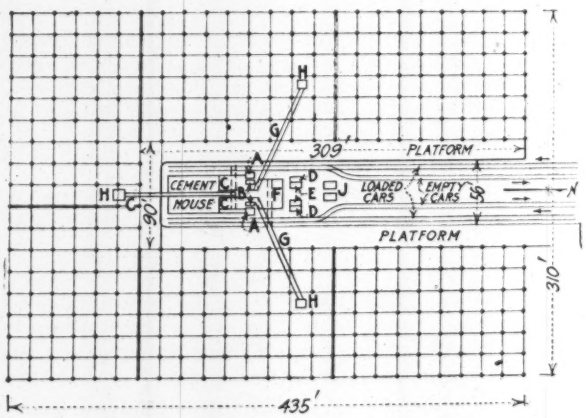


FIG. 2. PLAN OF CONCRETING PLANT FOR THE MONTGOMERY WARD CO., AT KANSAS CITY, MO.
(A, Towers. B, Mixers. C, Platforms. D, Hoists for towers. E, Hoists for clamshell buckets and car-puller. F, Bins. G, Inclined chutes. H, Floor hoppers. J, Boilers.)

bucket and to occupy as little room as possible between cars and storage bins. The hoists were placed immediately north of the bins, in the space left open by connecting the two center tracks to the outside tracks.

There were two clamshell buckets on travelers over the sand and stone bins respectively, so arranged as to deliver from the cars on the east track to the sand bin and from the west track to the stone bin. These buckets

were kept at such a height that a chute could be put under either one to chute the material across to the opposite side, so that either bucket could be used for either material.

In the first operation, a bridge was placed between the towers at a height to permit of concreting four stories without a change. From this bridge was suspended a hopper and three spouts extending to the three sections into which the building was divided for facility of operation. This hopper was connected with both towers and so arranged that any of three spouts could be fed from either tower. This made a very flexible plant and permitted of both mixers and towers working at the same time and supplying two spouts at the same time. When the four-story height had been reached, towers and bridge were raised to the final height to complete operations.

The spouts delivered the concrete to floor hoppers practically in the center of the spaces in which the building had been divided, and from these the material was distributed by means of buggies.

The clamshell buckets were operated by electric hoists which raised the clamshells to the travelers, where they traveled by gravity to a trip over the bins. The same hoists operated the niggerheads which pulled out the empty cars and pulled in the loaded cars. There were two trainloads of material a day delivered on each of the material tracks, making four trainloads per day. These trains were made up of various materials, so placed that the cars of steel and other material could be unloaded on the dock or platform north of the bins while cars of sand, stone and cement were being detached and pulled forward for unloading.

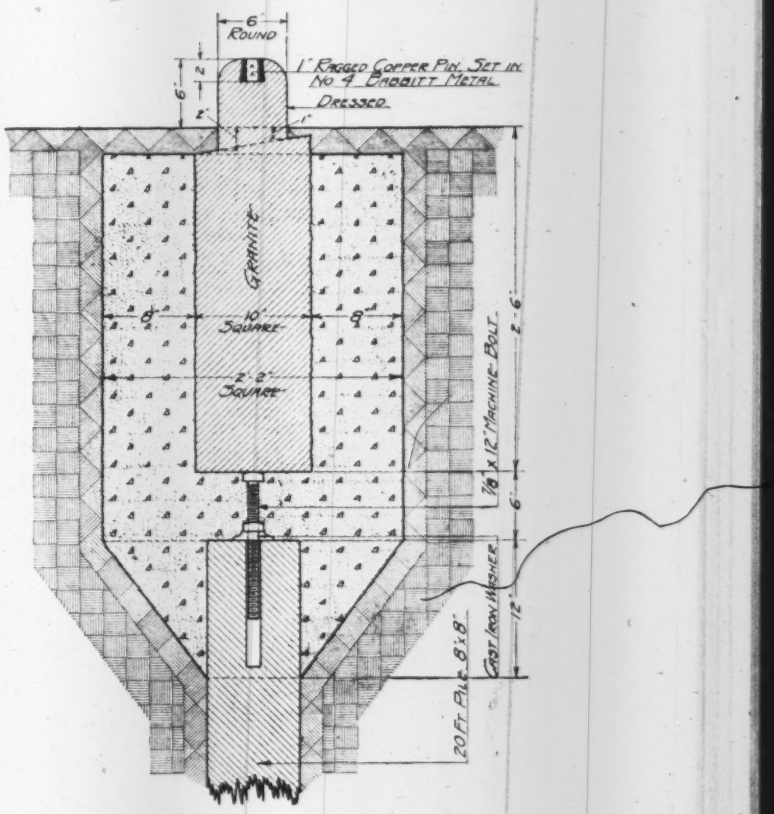
In the space between the tracks and north of the location of the hoists were two boilers, cross-connected, and connected with the steam coils which were located in the bottom of the material bins to heat the sand and stone, as most of this work was done in the winter.

Granite Benchmarks on Piles

An innovation has been made in the type of benchmark used by the New Orleans Sewer and Water Board (see ENGINEERING NEWS, Feb. 11, 1915, p. 268). Last summer it was found that a benchmark which had been placed about 20 ft. from a street-railway track and in close proximity to an open drainage canal had settled 0.3 ft. This threw suspicion on all other benchmarks similarly placed and so check levels were run over them. It was found that several had settled from 0.02 to 0.03 ft. It was decided to reset these benchmarks on piles.

Accordingly an 8-in. creosoted pine pile 20 ft. long was driven in the bottom of each excavation. A 300-lb. hand-operated hammer was used to drive the piles. It is the policy of the Sewer and Water Board to hold all benches to their published elevations, so a scheme had to be devised for resetting the benchmarks at their previous elevation. A ⅞x12-in. bolt was set in an auger hole in the top of the pile. A cast-iron washer, held in place by a nut, was slipped on the threaded end of the bolt under the nut. By means of the bolt the monument was set about ¼ in. above its original elevation and concrete was placed around the top of the pile and monument as shown in the accompanying sketch. After sufficient time for the setting of the concrete, the top of the monument and the copper plug were trimmed down to the elevation desired.

Owing to the elastic and compressive nature of the alluvial soil in New Orleans, the advisability of putting all standard stone benchmarks on piles (and of using concrete piles instead of creosoted timber) is under consideration. Levels on three benchmarks originally set on 6x8-in. by 16-ft. creosoted pine piles show a probable settlement of the whole area of about ¼ in.—C. B. ADAMS, Assistant Engineer, Sewerage and Water Board, New Orleans, La.



SKETCH OF GRANITE BENCHMARK ON PILE, NEW ORLEANS, LA.

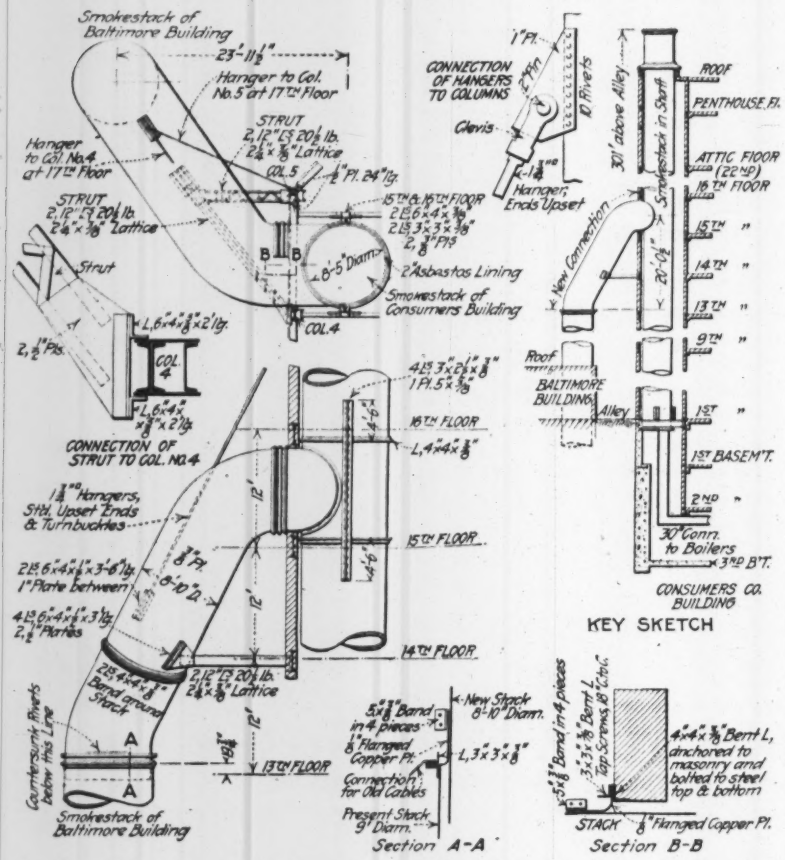
(Reproduced from original drawing of Sewerage and Water Board)

A Complicated Smokestack Connection

The new 22-story Consumers' Building, State and Quincy Sts., Chicago, has an 8½-ft. asbestos-lined steel stack in a shaft at the rear of the building. This stack, 301 ft. high above the street, was intended originally to serve a heating plant in the building, but later service was secured from a plant in the Baltimore Building, an older eight-story structure at the rear.

In the basement of the Baltimore Building is one of the heating plants of the Illinois Maintenance Co., which supplies steam for heating throughout the entire block and also for the Fair, a large building occupying the ad-

jacent block. The smoke flue from this plant extends in the building only to the third floor, where a connection is made to an unlined outside steel stack supported on cantilever brackets. It was realized that with this large power plant it would be impossible to control the smoke to such an extent that it would not be obnoxious to tenants in the higher adjacent Consumers' Building, while the smoke would soon blacken the white glazed terra-cotta facing of the rear of that building. In order to forestall these difficulties, the Illinois Maintenance Co. made arrangements to connect its outside stack on the Baltimore Building with the inside stack of the Consumers' Building.



CONNECTION BETWEEN AN OUTSIDE SMOKESTACK AND AN INSIDE SMOKESTACK AT TWO ADJACENT BUILDINGS IN CHICAGO

The arrangement is shown in Fig. 1, and the details in Fig. 2. As the two stacks are not in line the connection is inclined from north to south as well as from east to west. A special feature of the construction is that the connection (which weighs about 14 tons and extends across the alley) is supported entirely from the framing of the Consumers' Building, so that no part of its weight is carried upon the lower stack. The bottom of the connection simply telescopes into this latter stack, a flashing being arranged in the joint. This allows free expansion and contraction of the stack, while in case of fire and the fall of the walls of the Baltimore Building (a nonfireproof structure) the stack would drop away without affecting the Consumers' Building.

The connection between the two stacks is a shell 8 ft. 10 in. diameter, with an elbow at each end. The bottom elbow enters the top of the shorter stack, and the elbow connects to the side of the stack in the Consumers' Building. The weight is carried by [illegible] hangers with 2-in. pin attachments to brackets on the stack connection and pin plates on the columns of the building, as shown in Fig. 2. The lateral thrust is [illegible] by a pair of horizontal box-lattice [illegible] bearing against the columns of the building at the level of the 14th floor.

The design for this stack connection was made by Mundie & Jensen, of Chicago, architects for the Consumers' Co. Building. The steelwork was built and erected by the Hansell-Elcock Co., also of Chicago.

Tractor-and-Trailer Transportation for Street-Repair Work*

By Henry Welles Durham†

A careful investigation of street-repair methods in the Borough of Manhattan, New York City, showed that the use of motor vehicles instead of horse-drawn wagons would effect a large saving in transportation. With money saved out of the pavement repair allotment six gasoline-engine tractors were purchased at a cost of $23,970, and 13 trailers for use with them. It was intended to purchase nine additional trailers, but the contract price was so high that bids were rejected.

The tractor-and-trailer scheme converts the uneconomical short-haul conditions found in street-repair work to conditions of long hauls where the tractors may be continuously employed. The proposed scheme is to load a trailer at the plant, haul it out to the gang on the street, detach it from the tractor, whereupon the tractor goes back to the plant empty. It then takes out another load, returning with the empty trailer. In this way waiting time is reduced to a minimum. It is also intended to use the return trip for hauling the old asphalt and other material to dumps at the waterfront. On the street the road roller will be attached to the trailer and hauled to locations as required. This scheme was tried out with entire satisfaction, and all indications point to a great saving in transportation costs.

An Electric Well-Sounding Instrument

By Leslie W. Stocker‡

A study of the underground water-supply of the city and county of San Francisco was made in 1913 by Max J. Bartell, hydraulic engineer, under the direction of M.

*From a forthcoming Annual Report of the Bureau of Highways, New York City.

†Recently Chief Engineer, Bureau of Highways, Borough of Manhattan, New York City.

‡Assistant City Engineer, San Francisco.

M. O'Shaughnessy, city engineer. One feature of the investigation was the testing of a number of wells of large capacity which are used for the water-supply of industrial establishments and small residential districts. The general method of procedure on a test was as follows: The depth to the normal water level in the wall was ascertained by sounding before the pump was started in the morning. After starting, the depth to water was noted at short intervals until the condition of equilibrium was reached. The "draw-down curve" was thus determined. The speed of the pump was altered during the day and observations were made to study the fluctuation of the water level due

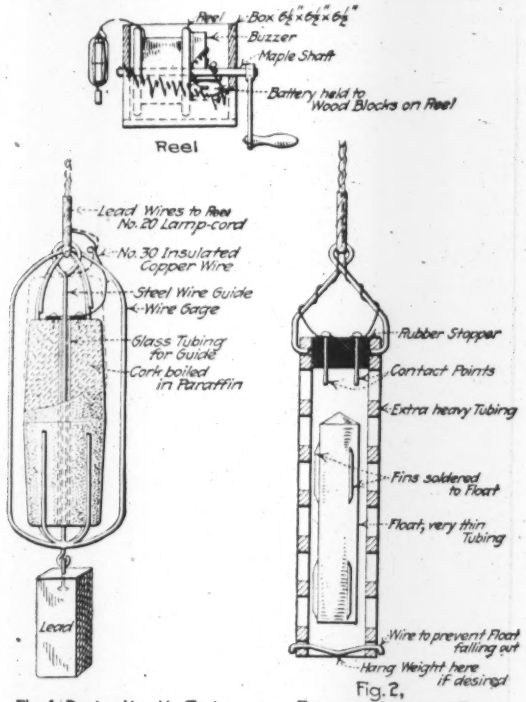


Fig. 1, Device Used in Tests. Fig. 2, Proposed Improved Form.

ACTUAL AND PROPOSED ELECTRICAL WELL-SOUNDING DEVICE

to variation of the rate of pumping. Then the pump was shut down, the reverse operation to that of the morning was performed, giving the "curve of rise."

The method of measuring the depth to water by dropping a tape down the well was not applicable because of the very short intervals between observations—sometimes only five or ten seconds. The instrument shown by Fig. 1 was invented for the occasion by the writer, and was used successfully on all the tests. It consists of a float which is free to move vertically through a short distance (about an inch) on a wire guide. A copper ring is fastened to the upper end of the float, and is connected by means of a small flexible insulated wire to one of the two conductors of the twisted lamp-cord by which the apparatus is suspended. The other conductor is connected to the guide wire. The upper ends of these conductors are connected to a buzzer and dry battery. The lamp-cord is graduated by means of adhesive tape or metal tabs so that the depth to which the apparatus has been lowered can be readily noted. A wire cage protects the float from contact with the well casing, and a lead sinker hangs from the lower end of the cage.

The sounding device is lowered into the well. On reaching the water level the float remains stationary while the rest of the apparatus descends through the range of travel of the float on the guide wire. The copper ring then makes contact with the ring at the upper end of the guide, closing the buzzer circuit and giving the signal to the observer that the water level has been found.

The instrument shown by Fig. 1 is a crude home-made affair. The float was made of two large corks, boiled in paraffin to prevent their becoming water-logged. A glass tube was inserted in the hole in the center to minimize the friction against the guide wire. The reel is a large annunciator-wire spool fitted with a shaft and crank and mounted in a box. The buzzer and a small dry cell are fastened on one end of the spool.

The lead sinker was made heavy in comparison with the weight of the cage and suspending wire so that it could be used to sound the total depth of the well if the pump did not interfere.

Satisfactory results were obtained at depths of nearly 200 ft., but there seems to be no reason for setting any limit on the range of action.

An improved form of this device could be made at small expense, as shown by Fig. 2. Here the cork float is replaced by a sealed copper or brass tube, and the wire cage and guide wire by a metal tube through which a number

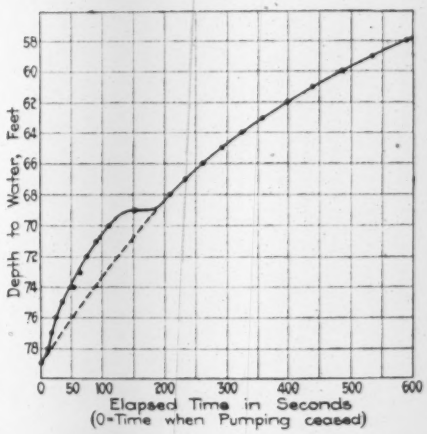


FIG. 3. CURVE OF RISE OF WATER IN WELL

Elapsed Time, Sec.	Depth to Water, Ft.	Elapsed Time, Sec.	Depth to Water, Ft.
0	79	207	68
12	78	232	67
18	77	257	66
26	76	290	65
36	75	324	64
52	74	362	63
64	73	399	62
74	72	442	61
91	71	487	60
110	70	535	59
152	69	589	58

of holes have been drilled to permit the water to enter or escape freely. The upper end of the outer tube contains a plug of rubber or other nonconducting material through which two contact points project. The suspending wires are connected to these points and the circuit between them is closed through the cap of the inner tube, eliminating the moving wire shown in Fig. 1. The outer tube is made of extra-heavy tubing so that no additional sinker is required. Fins are soldered to the float to keep it approximately centered, minimizing frictional resistance to its movement.

The precision of the results obtained with the well-

sounder is shown by the regularity with which the points fall on the plotted curve in Fig. 3. This is the actual curve of rise in a 10-in. well from which the water is raised by an air-lift with 3-in. discharge pipe. The peculiar form of the curve below the depth of 68 ft. is due to the backing down of the water in the discharge pipe, which is not provided with a check valve. This caused the water to rise faster in the well than in the ground until the water levels inside and outside of the discharge pipe had become equalized. The dotted line, which is the production backward of the upper portion of the curve, is the true curve of rise of the groundwater.

Rules for Subordinate Engineers on Municipal Work

There is often a tendency in public work to shift responsibility. Hence definite rules or instructions defining subordinate engineers' duties are more essential than in private work. Such a set of instructions are given herewith. These rules were drawn by M. M. O'Shaughnessy, City Engineer of San Francisco, Calif., but with variations should be applicable to any public-works engineering organization.

(1) Each assistant engineer and inspector on construction shall provide himself with a copy of the contract, plans and specifications and thoroughly familiarize himself with the terms thereof.

(2) No departure from the plans or specifications shall be permitted by the assistant engineer or inspector without the approval of the supervising engineer.

(3) Deal directly with the contractor, his superintendent or foremen, and give no orders to contractor's laborers.

(4) Enforce on the contractor the observance of the rights of property owners and the general public and permit no negligence that would endanger the safety of employees or others.

(5) Authorize no extra work without the approval of the city engineer.

(6) Regular working hours are from 8 a.m. to 5 p.m. Punctuality is essential. Unexcused absence from the contract while work requiring inspection is in progress will be deemed sufficient cause for dismissal.

(7) Allow no work that requires inspection to be performed except during regular working hours unless special arrangements are made with the supervising engineer for the inspection thereof.

(8) When work on the contract is suspended on account of rain or other cause, immediately report in person to the chief assistant city engineer.

(9) See that all materials to be incorporated in the work are properly tested and approved. Reject any inferior materials that do not comply with the specifications, and at once notify the supervising engineer of such rejection.

(10) Should the contractor or his agents refuse or neglect to comply with the plans and specifications or to perform the construction in a proper manner, direct him to suspend the work. Report at once to the supervising engineer.

(11) Keep a diary in which record each day all occurrences or matters of interest relating to the work. Make a written record of all instrument work; location of buried structures, such as pipes, valves, house connections, etc., measuring from some permanent surface reference, such as a property line, street monument, etc.; record inspections of materials; delays and accidents and their cause; authorized overtime and extra work; progress, etc.; and furnish to the city engineer on blanks provided for the purpose daily and weekly labor, material and cost reports.

(12) Keep a complete record of the names, dates of attendance, location and specific assignment of your assistants, if any.

(13) Assistant engineers and inspectors on construction will be held responsible for the quality of all materials and workmanship on the contract to which they are assigned, and for the strict fulfillment of the plans and specifications. Before final construction carefully check all forms, alignment and grades from references established by the city engineer's office.

(14) On the completion of any contract, or if tra... from any contract before its completion, immedia... liver to the desk clerk at the office of the city engi... plans, specifications, field notes and data in your po... relating to said contract.

Three-Centered Connecting Tracks Between Tangents and Curves

By S. E. Shoup*

Economy generally demands a three-centered curve for a track connecting a curve with an intersecting tangent; usually neither of the turnout curves is acceptable, being either too long or too short.

Suppose the problem is to lay out a track connecting a tangent and the outside of a 4° curve, using No. 10 frogs in both tracks. The radii of the turnout curves are definitely fixed as soon as the frogs are chosen. In this case, from the tangent the radius would be 941.6 (a 5° 43′ curve) and from the outside of a 4° curve a No. 10 frog would require a curve of 1° 43′, or a radius

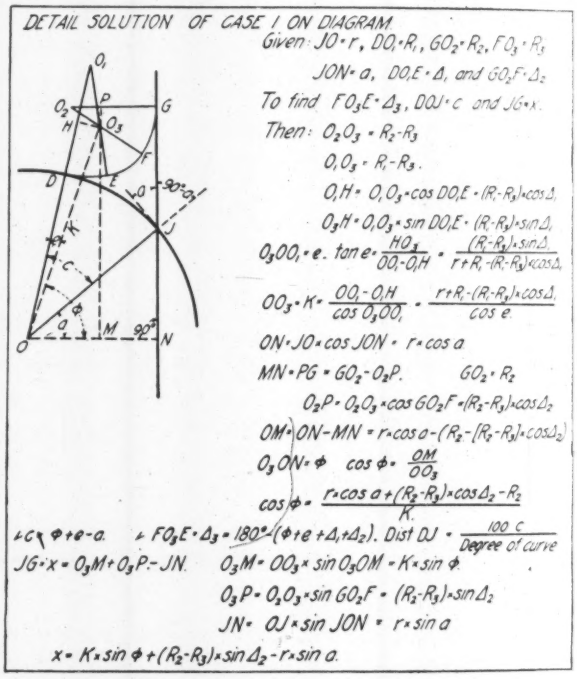

DETAIL SOLUTION OF CASE I ON DIAGRAM
Given: JO = r, DO₁ = R₁, GO₂ = R₂, FO₃ = R₃
JON = a, DO₁E = Δ₁ and GO₂F = Δ₂
To find FO₃E = Δ₃, OOJ = c and JG = x.
Then: O₂O₃ = R₂ - R₃
O₁O₃ = R₁ - R₃.
O₁H = O₁O₃ cos DO₁E = (R₁ - R₃) cos Δ₁
O₃H = O₁O₃ sin DO₁E = (R₁ - R₃) sin Δ₁
O₃OO₁ = e. tan e = HO₃ / OO₁ - O₁H = (R₁ - R₃) sin Δ₁ / r + R₁ - (R₁ - R₃) cos Δ₁
OO₃ = K = OO₁ - O₁H / cos O₃OO₁ = r + R₁ - (R₁ - R₃) cos Δ₁ / cos e
ON = JO cos JON = r cos a
MN = PG = GO₂ - O₂P. GO₂ = R₂
O₂P = O₂O₃ cos GO₂F = (R₂ - R₃) cos Δ₂
OM = ON - MN = r cos a - (R₂ - (R₂ - R₃) cos Δ₂)
O₃ON = φ cos φ = OM / OO₃
cos φ = r cos a + (R₂ - R₃) cos Δ₂ - R₂ / K
∠ JOC = φ + e - a. ∠ FO₃E = Δ₃ = 180° - (φ + e + Δ₁ + Δ₂). Dist OJ = 100 c / Degree of curve
JG = x = O₃M + O₃P - JN. O₃M = OO₃ sin O₃OM = K sin φ
O₃P = O₂O₃ sin GO₂F = (R₂ - R₃) sin Δ₂
JN = OJ sin JON = r sin a
x = K sin φ + (R₂ - R₃) sin Δ₂ - r sin a.

Fig. 1. Solution of Case I (Fig. 2)

of 3337.7 ft. Either of these radii would make a track unnecessarily long, and for the sake of economy they should compound to a shorter radius as soon as the frog is passed.

In all cases the two turnout curves will be fixed in radius, and except in rare cases frog angles will be taken as the central angles. Even in the other rare cases it is necessary from a practical standpoint to assume these angles. The radius of the central portion of the curve will be assumed according to local conditions or the practice of the railway. In most cases the degree of curve of the central arc will be the maximum the road allows.

*Kansas City Southern Ry., Kansas City, Mo.

The radius of the main-line curve will be known and the tangential angle at the crossing observed.

The notation used in these formulas is as follows: r = radius of main line; R_1, R_2, R_3 = longest, intermediate and shortest radii in connecting track, respectively; Δ_1 Δ_2 and Δ_3 = central angles of curves having radii of similar subscripts. An inspection of the diagram will develop the fact that the formulas change slightly for different sequences of radii in the connecting track. There can be six arrangements in each angle, making a total of 24 cases, of which the eight most probable are given in Fig. 2. It is believed that the arrangement of the formulas is such that the case which applies to a particular condition can be picked out by observation in the minimum time.

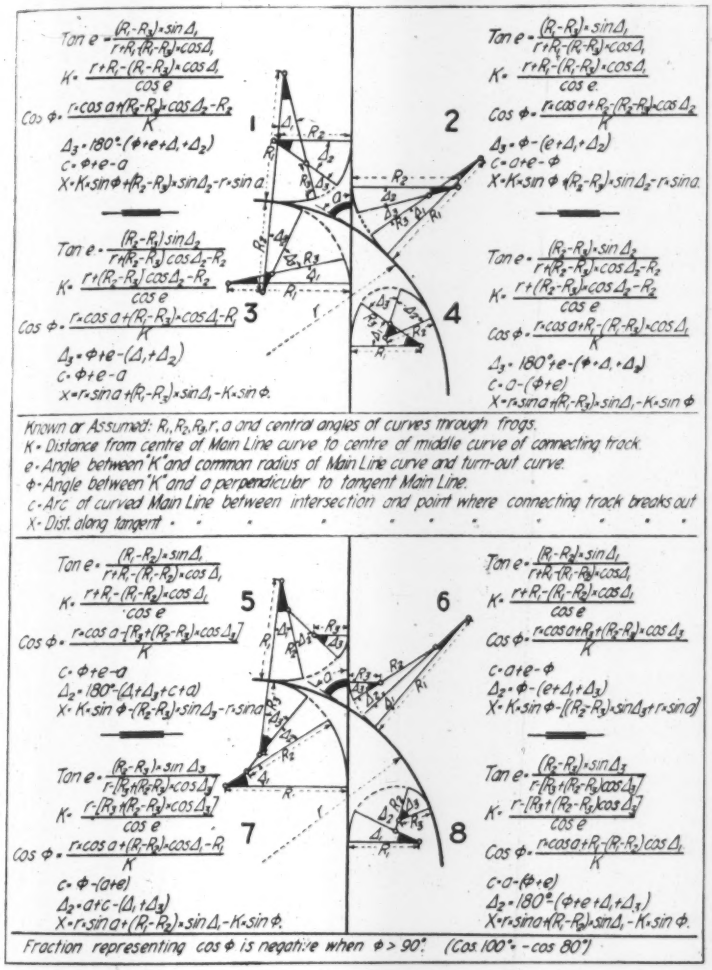

Known or Assumed: R1, R2, R3, r, a and central angles of curves through frogs.
K = Distance from centre of Main Line curve to centre of middle curve of connecting track.
e = Angle between 'K' and common radius of Main Line curve and turn-out curve.
Φ = Angle between 'K' and a perpendicular to tangent Main Line.
c = Arc of curved Main Line between intersection and point where connecting track breaks out
X = Dist. along tangent
Fraction representing cos Φ is negative when Φ > 90°. (Cos 100° = - cos 80°)

FIG. 2 DIAGRAM OF EIGHT CASES OF CONNECTING A TANGENT WITH A CURVED TRACK

Case I is worked out in detail in Fig. 1, and any case may be solved by analogous methods. Attention is directed to the fact that the tangential angle at the point of intersection of the main tracks is always the acute angle.

Certain unusual limitations must be observed. In Case I, however, this restriction is so remote as to have no actual value. In Case II, for instance, $\angle a - \angle c$ must be greater than $\Delta_1 + \Delta_2$. In Case III, $\angle a + \angle c$ must be greater than $\Delta_1 + \Delta_2$. In Case IV, r *vers* a must be greater than $R_1 - (R_1 - R_2) \cos \Delta_1 + (R_2 - R_3) \cos \Delta_3 + R_3$. Similar limitations apply to all other cases in their respective positions. These limitations exist only where the physical conditions in the field render a three-centered curve with the assumed elements a mathematical impossibility.

The growing tendency in trackwork is to take into consideration the fact that frogs are built straight, when staking out work. This practice is recommended by the American Railway Engineering Association. Because of this, theoretical turnout curves in common use involve taking the length from the point to the heel of the frog into all formulas in the form of $T \sin F$, and $T \cos F$, where the track continues beyond the frog. This makes the formulas cumbersome, and because of the added complication allows more chance for error.

The theoretical curve actually represents

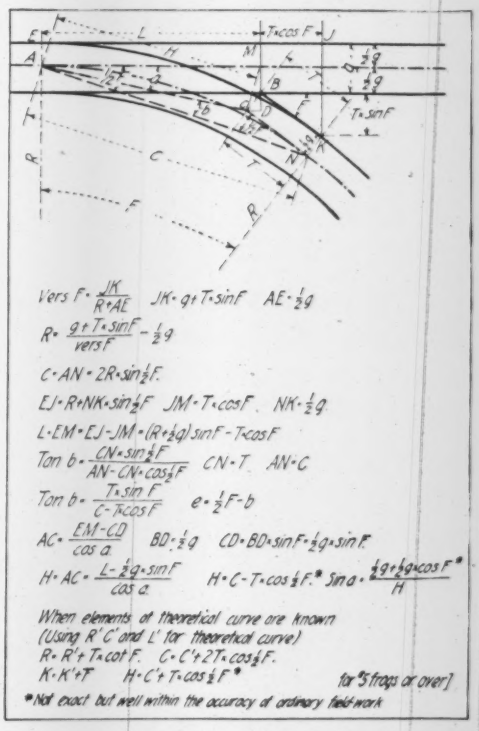

When elements of theoretical curve are known
(Using R' C' and L' for theoretical curve)
for 5 frogs or over]
* Not exact but well within the accuracy of ordinary field-work

FIG. 3. DIAGRAM AND FORMULAS FOR FROG-TANGENT CURVES

TABLE OF FROG TANGENT CURVES

Frog No.	Length of Frog Tangent	Frog Angle	Radius	Degree of Curve	Chord Length P.C. to Heel of Frog (P.T.)	Distance P.C. to P.F. Along Main Line	Distance from P.C. to Point of Switch	To Set Stake at Point of Frog on Straight Track with Instrument. Distance	To Set Stake at Point of Frog on Straight Track with Instrument. of Curve	To Set Stake at Point of Frog on Straight Track with Instrument. Pt. Angle
4	5.0	14° 15′	190.67	30° 24′	47.30	42.67	2.67*	42.34	6°	17′
5	6.5	11° 25′	300.41	19° 10′	59.78	53.58	8.58*	53.31	5°	01′
6	7.0	9° 32′	423.00	13° 35′	70.25	63.50	9.50*	63.28	4°	14′
7	8.0	8° 10′	573.40	10° 00′	81.70	73.91	13.41*	73.72	3°	38½′
8	9.0	7° 09′	746.66	7° 41′	92.15	84.33	17.33*	83.67	3°	12½′
9	10.0	6° 22′	942.75	6° 05′	104.58	94.75	25.78†	94.60	2°	50½′
10	11.0	5° 43′	1161.62	4° 56′	115.01	105.17	28.17*	104.53	2°	34½′
12	12.0	4° 46′	1644.04	3° 29′	136.87	125.00	34.13†	124.89	2°	09½′
15	15.0	3° 49′	2568.67	2° 14′	171.15	156.25	34.90‡	156.16	1°	43½′
16	15.0	3° 35′	2922.60	1° 58′	182.58	166.66	46.66*	166.59	1°	37′

* Taken from Baltimore & Ohio R.R. standard.
† Taken from Kansas City Southern Ry. standard.
‡ Taken from St. Louis & San Francisco R.R. standard.

nothing and is only a convenience for referring computations to the center line of the track, all turnouts being laid by special plans that control everything in front of the frog. Since this is the case, a curve may be substituted which serves the same purpose as the theoretical curve, simplifies the formulas and takes into account the frog tangent.

This may be called the frog tangent curve and differs from the theoretical curve in that it becomes tangent at the heel of the frog instead of at the point. It makes the distance from the point of curve to the point of switch longer by the length of frog tangent, but it is certainly just as easy to measure 26 ft. as 16 ft., and this method is much simpler in handling compound-curve problems or cases where the curve continues beyond the frog.

The formulas derived for this curve are shown in Fig. 3, and in the accompanying table will be found the angle and distance necessary for the location of the stake opposite the point of frog when occupying the point of curve. If the stake at the heel of the frog only is occupied, as many engineers prefer to do, it is only necessary to measure back the frog tangent distance when the frog angle has been turned. It will be noted that the frog tangent curve is readily obtainable from the theoretical curve. In the table, no authority is given for the length of frog tangent. These lengths were carefully selected from the standards of a number of leading railways, and represent the general average.

NOTES

Field Tests of Concrete on the new buildings for the Massachusetts Institute of Technology at Cambridge, Mass., were reported in a paper by Sanford E. Thompson at the recent meeting of the American Concrete Institute. Over 100 specimens of 8x16-in. cylinders were poured simultaneously with the pouring of different parts of the buildings. A 1 : 1½ : 3 concrete tested at the end of 28 days gave an average crushing strength of 2520 lb. per sq.in., and a 1 : 2 : 4 concrete of the same age an average of 2010 lb. per sq.in.

Rapid Shovel Excavation in Road Grading—A steam shovel equipped with a ⅝-yd. dipper moved 1000 cu.yd. of material in a 10-hr. day on road-grading work in the Adirondack Mountains, according to a report by Beede Bros., contractors, Keene Valley, N. Y., to the Bucyrus Co., whose shovel was used on the work. The highway, built last summer, is part of the extensive state-road work in the Adirondack region and extends from Jay to Upper Jay, Essex County, through the valley of the Ausable River. The shovel worked in a side-hill cut 1000 ft. long. The average slope of the hill was 2 on 1 to a height of 75 ft. The machine worked parallel to this slope for the whole 1000 ft., taking out the toe to an average width of about 20 ft. and digging 12 to 18 in. below subgrade. The soil was clay with a top deposit of sand. The sand was of such good quality that it was used as a filler for the boulder sub-base to bring the road to grade.

No attempt was made to slope the cut, so that it was necessary to pull down a large amount of material after the shovel had passed. To do this, longitudinal ditches were dug above the cut, cutting through the mat of sod and fine tree roots. By this means it was usually easy to cause a heavy slide; where necessary, a light blast was used.

A 5000-Mile Motor-Truck Trip on geodetic work was made last year by a party of the U. S. Coast and Geodetic Survey. An astronomical party, under C. V. Hodgson, was taken from Denver, Colo., to Needles, Calif., through Pecos, El Paso, Douglas, Tucson, Phœnix, Yuma, San Diego, Los Angeles, Mojave, Sacramento and Carson City. The trip was remarkable when it is considered that observations were made frequently on mountain peaks, so that the journey was from mountain to mountain rather than along traveled roads from town to town. Full-capacity load was carried over roads varying from deep mud, in New Mexico and Texas, and the heavy sands of the Colorado River, to good highways of central and southern California.

The cost averaged 3.9c. per mile for oil and gasoline, varied from 2.7 to 6.6c. The work was done about cheaper than if teams had been employed. The party was in the field from May to October, in which time only two days was lost by engine troubles.

On a cañon road in western Texas, Mr. Hodgson's party and outfit had a narrow escape when a small cloudburst in a few minutes transformed the road into a river. There was no time to put on chains, but ropes were quickly wrapped around the rear wheels and the truck was run up a steep slope until stalled in the rising water. The truck was then moored to mesquite bushes, but the water soon ceased to rise. Had the truck remained where the water first struck it, it would have been almost completely submerged and probably overturned and damaged by drifting timbers.

It was in the desert sands, however, that the greatest difficulties were encountered, as the truck was fitted with ordinary solid rubber tires (dual behind) which cut in deeply. Many expedients were tried, but the most successful one was the use of green poles placed in front of the dual-tired rear wheels. These poles gave traction and kept the wheels from sinking into the sand.

To Find the Offsets to a Curve from the Long Chord—I have read with interest in your issue of Dec. 10, Mr. Price's demonstration and solution for finding tangent offsets to a curve when given a long chord and its middle ordinate. I have often had the same problem to solve and have used the following formulas taken from any standard fieldbook. The symbols in these formulas are the same as those used by Mr. Price:

$$R = \frac{L^2 + 4M^2}{8M}$$

$$y = R - \sqrt{R^2 - D^2}$$

These two formulas may be developed at any time, as they are based on simple geometry and, while they are not new, may be of interest.—Crosby Tappan, Engineer of Construction, Cumberland Valley R.R., Chambersburg, Penn.

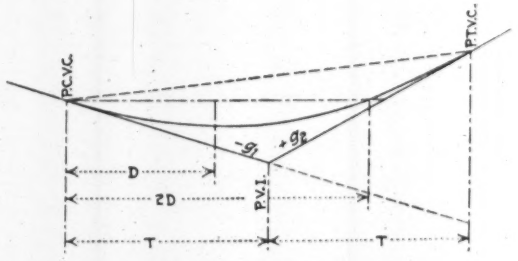
Location of Low Point of a Vertical Curve in Track—At any change of grade in track the location of the sag or summit of the vertical curve will not be the same as the grade-intersection (P. V. I.), except in the special case of equal grades in opposite direction. Ordinarily it is not important to predetermine the location of the low or high point, but in subway work it is necessary to locate the sags because pumping sumps must be constructed at these points. M. A. Drucker (Public Service Commission, New York City) gives a simple formula for locating the sag. If

D = distance from P. C. V. C. to low point;
T = tangent distance, equal on both sides of the P. V. I.;
g_1 = first gradient;
g_2 = second gradient;
$g_1 + g_2$ = arithmetical sum of gradients;

then the formula is

$$D = \frac{2\,g_1\,T}{g_1 + g_2}$$

It is based on the assumption of a parabolic curve, whose tangent offsets vary as the squares of the distances. Re-



ferring to the sketch, the offset at 2 D is $2\,Dg_1$, and the offset at the P. T. V. C. is $T(g_1 + g_2)$; equating their ratio to the square of the ratio of the distances $\frac{2D}{2T}$, the above-given formula results.

Bruner Floor Hardening System—In describing P. M. Bruner's drying-out system for producing a nondusting concrete surface, p. 221 of our issue of Feb. 4, 1915, we misprinted the name of the company which handles this system. The correct name is Bruner Granitoid Co., St. Louis, Mo.

Editorials

A New Engineering Society

About the time the bills for annual dues comes around each engineer must feel that technical societies have multiplied beyond his capacity for enjoying them, and this individual opinion might be fortified if he knew that nearly 400 such societies are listed in an index kept in the office of ENGINEERING NEWS. Were any additional evidence of the gregariousness of engineers needed, the recent organization of a society of technical society secretaries, noted on another page, would suffice.

And yet this new society can serve a very useful purpose, even though of necessity it must be of limited membership and its proceedings of immediate interest only to its members. The management of a technical society must be largely vested in the secretary, the only permanent officer, and its success or failure is often in his hands. Any organization which will tend to educate that secretary or to promote better relations between the various societies is an asset to the many members of the many societies, which in effect is the profession itself.

A Bill to License Stream Pollution in New Jersey

For many years New Jersey was one of the few states that controlled stream pollution with a vigorous hand. One by one others have joined the ranks and at present bills to the same end are before the legislatures of a number of the more backward states. It is, therefore, untimely to be promoting so reactionary a bill (Senate 226) as was introduced in the New Jersey legislature a few days ago.

The proposed bill would take from the State Board of Health its powers over sewage disposal into any running stream at points below the lowest municipal water-works intake on that stream. The effect of the bill, if enacted, would be to license sewage discharge regardless of nuisance and regardless of possible future sources of water-supply, provided only existing sources of municipal supply were not affected.

It seems unlikely that so reactionary, selfish and short-sighted a bill will become a law, but that should not be taken for granted by those whose duty and interest it is to see that the bill is killed.

So far as we know, the New Jersey State Board of Health has exercised its large powers of control over sewage disposal reasonably. The reactionary legislation proposed, even though wholly unwarranted, may nevertheless well make it and similar authorities in other states more solicitous than ever not to go to extremes.

The Redevelopment of Old Hydraulic Powers

The passing of one of the famous old water-power canal developments of this country, that at Cohoes, N. Y., and its replacement by a modern hydro-electric station is outlined on another page. The consummation of each such economically desirable redevelopment brings to mind the constantly decreasing list of important old-time powers in the eastern part of this country. Some of the other notable old water powers which still exist are those at Holyoke, Lowell and Lawrence, Mass., Manchester, N. H., Bellows Falls, Vt., Rochester, Watertown, Carthage, Oswego and Schuylerville, N. Y., with from 2000 to 15,000 hp. in capacity of installed wheels. Each one reminds us of the advantages that would arise from widespread redevelopment of our Eastern water powers along modern lines. But every present attempt to improve matters brings us face to face with the widespread burdens of distant warfare we carry, in this day of commercially interlinked countries, through the loss of millions of dollars worth of capital without any hope of return.

There is perhaps a ray of hope, for under conditions of reduced available investment capital, the redevelopment of old water powers possesses a few notable advantages over entirely new projects. First, the market is at hand and assured. Generally an appreciable reduction in price can be made under the cost of old canal power and still the business can be made to yield an attractive return on the new investment. Secondly, the total cost per unit of capacity of the change from old to new plants is frequently low because of the partial utilization of existing hydraulic works, like dams and canals, and the elimination of long transmission lines and transforming apparatus for a considerable amount of the business carried. Communities and industries have sprung up in the neighborhoods of the old developments and the new concern is able to transfer to itself much of the "going-concern" values of the small individual developments. Moreover, the advantages of the change do not inure exclusively to the new concern. For, in addition to any power-cost reductions, where the new company acquires a multitude of small water rights one of the advantages urging each owner to relinquish the generation of his own power and to accept central-station service is the recovery of valuable space occupied by head and tail races, flumes, pits, etc. There is also the elimination of maintenance costs on his own hydraulic plant, or of danger of damage from leakage and breakdown.

The community, too, receives a proportionate benefit. In all of these old powers there have been so many elements of inefficiency that the total power which can be developed may be increased from 25 to 100% and more, though a part of the gain will come from the development of storage facilities possible under unification of all the power rights. The old machinery is usually ill designed, rickety and leaky. There is usually a loss of head between each two canals or dams and each privilege is generally not fully utilized. Often only the parts of a local fall best adapted to low-head plants have been employed. Thus, after the needs of industries dependent on the old powers have been satisfied, there always remains

a large block of electric power available for the community, to displace more or less obnoxious coal-burning plants and to add at least a mite to the conservation of fuel resources. Not least among the advantages which a community gains is a desirable tendency away from the huddling of factory buildings in restricted areas close by the old power canals, with a consequent reduction in fire damage and insurance hazards.

State Competition with Private Engineers

The report in our last week's issue of the annual meetings held by the state engineering societies of Iowa and of Minnesota were of wide interest in that they described protest made at these meetings against the work of certain state organizations, which in the opinion of a large proportion of the engineers, are competing with engineers for work. A similar question relating to the competition of professors in engineering schools of State universities with private engineers was discussed in a letter published in our issue of Feb. 11, and is answered in this issue by four well known men connected with engineering schools.

The questions raised in these controversies are not wholly one-sided by any means. There have been cases where men have nominally held a chair in an engineering school and yet have devoted the bulk of their time to outside consulting practice. In some cases of this sort the university authorities were quite as much to be criticized as the professors. It was apparently the distinct intention in engaging the man's services to have the institution benefit not by the actual work of instruction which the man in question did, but by the prestige given to the department by the use of his name. Such cases, however, are exceptional; and there is much to be said in support of the claim that engineering is a profession which should be taught to its students by men actively engaged in professional work.

The situation in Iowa, however, is not a mere case of individual professors engaging in engineering practice on the side. There engineers are confronted with a state organization which offers to furnish engineering service at a low price or gratis not only to cities in the state but to manufacturers and other private concerns. Surely if such an organization is backed by the prestige of the State's university, the private engineer who has to make his living from the practice of his profession will have little chance in the competition.

Our readers will recall that some years ago, when there was a brisk discussion in this journal over the action of certain state highway departments in undertaking control of all highway-bridge work within the state, it was argued in defense that very little of this highway-bridge work is done by engineers under present conditions anyway but the structures are let by contract to bridge companies with little or no engineering supervision. Similarly, it is urged in defense of the Technical Service Bureau of Iowa that it only aims to furnish engineering advice where engineers would not otherwise get a look-in at all and that it is intended to be an entering wedge to secure the employment of private engineers rather than to compete with them and drive them out of business.

There is no doubt that in rural communities and the smaller cities a great deal of work is done in a haphazard manner without engineering advice or supervision simply because those responsible for it do not know how to get an engineer suited to their needs whom they would be willing to trust. It was entirely evident, however, that the engineers in private practice who were present at the Iowa and Minnesota meetings did not look with favor upon the Technical Service Bureau idea.

There is one comment upon this whole general controversy that can safely be made without fear of contradiction. That comment is that the plan of doing engineering work ought to succeed and is most likely to succeed which furnishes a service adapted to the work on hand at the lowest cost. It is an engineer's business, according to the classic definition, to make a dollar earn the most interest. The work of building sewers and waterworks and lighting plants and bridges, and improving streets and sidewalks in small towns and villages must be done at very low cost or it cannot be done at all. It follows that such work must be done by engineers who can afford to work at a moderate price. Men whose time is worth $50 to $100 per day cannot undertake such work for the engineering expenses would soon exceed any saving they could effect. On the other hand, if it is attempted to unduly economize in preliminary studies and investigation on such work, expenses are likely to be incurred in the construction which fuller investigation may show would have been wholly unnecessary.

The usual tendency in small towns is to economize to the last penny in engineering expenses. Those in charge consider the engineer merely in the light of a skilled workman who uses a peculiar looking instrument on three legs for measuring purposes. So far as the general planning of the work is concerned—be it a waterworks, a sewer system, an electric-lighting plant or any other public utility—the local officials in charge are apt to consider themselves as competent to do such planning as any of the engineers who could be hired.

This may very possibly be the case as respects such engineers as they number among their personal acquaintance. On the other hand, an engineer thoroughly familiar with the latest practice and commercial conditions in any of these fields can, almost without exception, make plans for construction which will involve far less cost and secure far better results than any layman.

The question of competition between state organizations and the private engineer turns largely, it seems to us, on the question, "what kind of service either can furnish?" It must be generally admitted that the individual engineer working alone or with only one or two assistants can cover usually only a very limited field, and will find it difficult to compete with the service that might be rendered by a state organization, with the prestige which naturally would attach to the latter. On the other hand, there are private engineering organizations which have so systematized their business and adopted such modern methods in carrying it on that any state organization, hampered as it necessarily must be with more or less red tape, will find it very difficult to give as good service.

Progress Toward Wiser Railway Regulation

In the railway world today, the crimes of the fathers are being visited upon the children. It is easy to trace the connection between the oppressive laws and regulations imposed on the railways and the mistakes and mis-

deeds of a past generation of railway officials. A remarkably frank declaration as to the change of heart which has taken place among railway officers was recently made in a published statement by Samuel Rea, President of the Pennsylvania R.R., Daniel Willard, President of the Baltimore & Ohio R.R., and Theodore Voorhees, President of the Philadelphia & Reading Ry., representing the twenty-one railway companies of New York and New Jersey, which are appealing to the legislatures of those states for repeal of the full-crew laws. We quote:

> We frankly admit that in the past railroads have been too slow in introducing safety devices, partly owing to the costs involved, but largely because of a stupid and stubborn attitude of mind once too prevalent among railroad managers. In many cases these managers did what was obviously right and to the advantage of the railroads, their employees and the public, only under compulsion of public opinion and enforcing laws. Railroad managers as a body have reached a more enlightened state of mind.

It is difficult today to appreciate just how hidebound and ultra-conservative was the typical railroad officer of a generation ago. Some remarkable examples are given in an interesting old book on railroad accidents, written by Charles Francis Adams, 36 years ago, just after he had completed ten years' service on the Massachusetts Railroad Commission.

The railway era began before the telegraph was invented and for some thirty years railways were operated without the use of the telegraph. The timetable was the sole reliance for keeping trains from colliding with each other. It was about the time of the Civil War that the movement of trains by telegraphic orders was adopted. Some twenty years later, in 1879, Mr. Adams wrote:

> Within a very recent period the superintendent of a leading Massachusetts R.R. gravely assured the railroad commissioners that he considered the control of train movements by telegraph a most dangerous reliance, and he had no doubt it would be speedily abandoned in favor of the old time-table and running rule system.

Mr. Adams also gave in the same book some interesting incidents of the early opposition to the use of the Westinghouse air brake. In 1871 a rear collision occurred at Revere, Mass., in which practically all the passengers in a crowded car were killed or injured. It was clearly established that the accident would have been avoided had the train been equipped with air brakes. A meeting of Massachusetts railroad officers was called to discuss this accident and one prominent official was asked if the road under his charge was equipped with the most improved brake. He indignantly replied that it was; that it was equipped with the good old-fashioned hand brake, and he was ready to stake his professional reputation on its absolute superiority to any other brake in existence.

At the same meeting a description was given of the block system, which was then not only unused but almost unknown in the United States. One veteran superintendent remarked that while the system might possibly work well, he would not dare take the responsibility of operating any such crowded traffic as he had charge of under such a system!

We cite these instances of the ignorance and old fogyism of a dead and gone generation of railway officials merely to show the great change that has taken place. No doubt the educational influence of the technical school and the technical journal has been influential in producing this change.

Nowhere has the change been more marked than in the attitude of railway officers toward the public. Twenty-five years ago there were very few railway officials enlightened enough to admit that the state had any business to interfere with railroad operation. Today it is difficult to find one who does not recognize that public regulation of railways has come to stay and that it should be welcomed and not opposed by the railways.

In a recent public address before the commercial organizations of Philadelphia, W. W. Atterbury, vice-president of the Pennsylvania R.R., said: "I believe in railroad regulation. Railroads have benefited from regulation in ways many of them little realized. It is the duty of the railroad officer to coöperate in making that regulation a continued benefit to the country."

While Mr. Atterbury thus frankly recognized the necessity and advantage of public control, he declared with equal frankness that the railways and the public are suffering from incompetent regulation. We quote further from his remarks as follows:

> No step in my judgment could be taken by the business men of the country more fruitful of practical benefit than action to insure that any man appointed to regulate our railroads shall be qualified by experience and training to pass upon the important questions which will come before him. I suggest that a minority of the railroad commissioners, federal and state, should consist of men trained in the practical conduct of railroad affairs and all appointments should be for life or good behavior and that the salaries should be such as to attract the ablest brains in the country.

It is noteworthy in this connection that Charles Francis Adams, from whose book we have quoted above, and who was a pioneer in establishing state regulation of railways in this country, has in a recent published statement condemned the present tendency toward unwise railway legislation and railway regulation by politicians, as constituting a national danger.

The recent investigation of the New York City Public Service Commission has aided to make clear to the public the necessity of putting high-class men in places involving such great responsibility.

Mr. Atterbury's plea that men familiar with railway operation should be chosen, at least in part, for the membership of public-service commissions was echoed by William M. Ivins, of New York, in testifying on Feb. 25 before the legislative board. The New York law makes men connected with public utilities ineligible for appointment, thus, said Mr. Ivins, making it impossible to obtain experts for work requiring expert knowledge.

It is probable that in the present state of public opinion it would be impracticable to appoint railway officers as members of a commission to regulate railways. The public would assent, however, to the appointment of engineers on such commissions; and there are many engineers not now connected with railways who could bring expert knowledge to such a task.

It is a very great pleasure to be able to conclude this note with a recent instance of the appointment of an engineer to such a position. Chas. C. Elwell of New Haven, who has been for four years a Chief Engineer of the Public Utilities Commission of Connecticut, has just been appointed by Gov. Holcomb a member of the Commission. It is noteworthy also that Mr. Elwell (who was recently made President of the Connecticut Society of Civil Engineers) was for 18 years an officer of the New York, New Haven & Hartford R.R. Co. prior to his appointment as the Commission's Chief Engineer.

Letters to the Editor

The Quantity Surveyor's Bond

Sir—The friends of the quantity surveying method will be much pleased at your partial recommendation in the Feb. 11 issue of ENGINEERING NEWS. Likewise the success of the Engineers' Club of St. Louis in getting official recognition of the method in that city deserves the highest commendation.

However, the writer regrets that a definite standard of efficiency and responsibility for the survey is not fixed by the St. Louis Ordinance. No one can take off quantities with absolute accuracy; consequently the permissible variation should be stated. The most painstaking and careful work should be demanded. A provision that the totals of the different classes listed must be correct within say 3% would have set a standard high enough to assure the best service.

Under the bond clause of the St. Louis Ordinance it will be difficult to collect damages because it is questionable at what point of variation from true accuracy negligence or incompetency can be charged. On many jobs a bond of $10,000 is not large enough to give proper protection to the contractor and owner. If the amount of the bond could be fixed as a percentage of the estimated cost of the building, equal protection would be afforded on all jobs. A bond for 10% of the estimated cost would give sufficient protection. This would necessitate a separate bond for each job. Such a bond should be drawn up to protect both contractor and owner.

WM. GRAVES SMITH,
President, The Quantity Survey Co., Inc.
30 East 42d St., New York City, Feb. 23, 1915.

What Transverse Forces Act on Railway Bridges?

Sir: The excellent article by R. Fleming on "Wind Stresses in Railway Bridges" discusses the other transverse loads. I regret very much that he did not take these up more fully. The lateral forces which act upon a bridge on a tangent are:

(1) Wind.

(2) The pressure caused by inequalities in track and imperfections in rolling stock.

(3) The tendency of the individual girders or trusses to rotate about an axis through their end shoes.

(4) The tendency of the compression chords to buckle as separate struts.

The author has covered (1) very thoroughly. The allowance for (2) will depend upon the care bestowed upon track, locomotives, and cars. If defects in any or all of these cause the train to be deflected from a straight line, the force developed is applied to the bridge. But 4% seems too large an allowance; it would assume an effect equal, at 60 mi. per hr., to that produced by a 1° curve.

Mr. Fleming indicates that there are other forces and I think that most engineers understand this without allowing for them any definite quantities. In the last few years we have made at the Institute several structural models on about one-sixth scale, conforming closely to actual practice. While subject neither to wind nor vibration, these had barely strength to carry their own weight until the transverse bracing was inserted.

Causes (3) and (4) seem very important because there are numerous cases where they are the only transverse forces; because in an average bridge their intensity must be such as to make their consideration important; and because these stresses act all the time and reach their maximum as often as the main members. Their amount may be developed in a manner similar to the analysis of the lacing for compression members.

HORACE R. THAYER,
Carnegie Inst. Technology.
Pittsburgh, Pa., Feb. 23, 1915.

Competition by Professors in Engineering Schools

Sir: Replying to "Consulting Engineer's" letter in your issue of Feb. 11: Many people living in the vicinity of engineering colleges naturally come to them for engineering advice because the consulting engineers are not sufficiently well advertised so that these people know of them. Some of these people at least would do without engineering advice if they were referred to local engineers' so as an economical proposition only, it is better that the college professors should offer their services at a price that the public will pay, which is exactly what the consulting engineer does.

Very rarely do professors compete in price with commercial engineers; and if student assistance is utilized, it is paid for at as high a rate as they could earn at any other work available. Your correspondent has not apparently stated the case correctly when he says the man who can do the work at the lowest figure survives. It appears more nearly exact to say that it is the man who can get work at the best price the public will pay who survives.

As to the use of the university facilities in connection with such work, it is customary in some places to pay the school say 10% of the fee for such service.

If the use of the official stationary does deceive, it is not justified; but very often the results given out by one man may be the combined effort of himself and of several of his colleagues who have freely given their assistance. If the grade of such work is below that of the commercial engineer, the reason is not apparent. The commercial engineer may be a graduate of a few years' standing who consults his professor from time to time when he gets in a pinch. Moreover the professor is apt to be more deliberate in his work because he looks upon it as an engineering achievement rather than as a means of earning a certain fee.

As to whether such work may interfere with instruc-

tion it may be said that the instruction work is generally fixed in amount and cannot be shirked even if desired. The outside work is done on what would be called "overtime" in commercial work.

As to the possible detrimental effect on the student, he is not foolish enough to think that he loses anything because his instructor is able to do a grade of work which is of commercial value. If this same student should ask information of the outside engineer, he would fail to get what he wanted; but the professor freely gives of the results of his investigations and gives the student an insight to the conditions he may expect when he goes out for work on his own account.

Even if all of your correspondent's points were admitted, there is not enough of such work being done by college professors today to cause any worry on the part of the commercial fraternity and the practice is subject to the same economic laws that their work is.

E. G. GREENMAN,
Asst. Prof. of Mechanical Engineering,
Michigan Agricultural College.

East Lansing, Mich., Feb. 15, 1915.

Sir: The letter signed "Consulting Engineer" in ENGINEERING NEWS of Feb. 11, raises a question which has given technical schools very serious thought. At the present time some of our prominent engineering schools are working out the proper limitations under which the private practice of professors may not only be permitted but encouraged. As chairman of a committee of the Faculty of the University of Minnesota to recommend to the Board of Regents the principles which should govern in this matter, it became my task to investigate the situation very fully. Out of the recommendations of the committee, with some modifications by the Regents themselves, the rules printed below were developed:

UNIVERSITY OF MINNESOTA: REGENTS' RULES ON PRIVATE PRACTICE. JUNE 10, 1914

1. No full-time member of the faculty shall engage in any outside activity which substantially interferes with his regular university duties. Such employment should contribute to his growth and efficiency in his special field of work.

2. No full-time member of the faculty shall receive from any outside source either an annual retaining fee or a regular salary unless the arrangement shall have been concurred in by the Board of Regents.

3. Any understandings now (June, 1914) existing between the University and members of the staff with reference to private practice shall be made a matter of record. This shall apply also to new members of the faculty when they join the University staff.

4. No member of the faculty who engages in consultation or other private practice shall use the official stationery of the University or give as a business address any building or department of the institution.

5. No member of the staff shall use University technical equipment for purposes of private practice without notice to the comptroller and the payment of a reasonable fee for the privilege enjoyed. (See 9 and 10 below.)

6. While it is not possible to draw the line definitely between professional service of an expert or consultative character and routine professional work, the University is opposed to the entrance of University men into ordinary competition in the various professional fields.

7. No member of the faculty shall accept employment which shall bring him as an expert or in any other capacity into antagonism to the interests of the State of Minnesota.

8. Every member of the teaching staff who gives professional opinions must protect the University against the use of such opinions for advertising purposes. That is, when a member of the staff does work in a private capacity he must make it clear to those who employ him that his work is unofficial and that the name of the University is not in any way to be connected with the transaction.

9. No member of the faculty shall undertake for private persons or corporations, tests, assays, chemical analyses, bacteriological examinations, etc., of a routine character and which involves the use of the University property, without notifying the comptroller, by whom permits for the work will be issued. The faculty member to whom the permit is issued shall collect fees from those who receive the services, and account to the University monthly for its percentage of the fees as fixed in the list of prices mentioned in Item 10 or in the permit.

10. It shall be the duty of the comptroller to prepare in conference with the various departments concerned a list of prices for the different types of work which the University can undertake for private individuals or corporations, and the percentages which shall be paid to the University for the use of its equipment. In special cases not covered by the comptroller's list, the price for the work to be done and the University's percentage shall be fixed in the permit authorizing the service.

While it was urged by the chairman of the committee that a statement concerning fees should be incorporated, so that professors might not undercharge, it was deemed wise to leave that to professional ethics. It should be added that a number of the members of the Faculty of the College of Engineering are serving as consulting engineers or as architects in important matters.

FRANCIS C. SHENEHON,
Dean, College of Engineering,
University of Minnesota.

Minneapolis, Minn., Feb. 18, 1915.

Sir—In your issue of Feb. 11, "Consulting Engineer" requests a discussion on the topic suggested by the title.

If "Consulting Engineer" desires to reduce competition, he has suggested the proper means of accomplishing that result. Let all teachers be chosen for their ability as theorists. Do not let them practice their profession. In a few years they will be splitting hairs on nonessentials and their graduates will be as impractical as they are. In this manner the competition, not only of the professors but also of their numerous students, may be avoided. Thus "Consulting Engineer," if he lives long enough, will only have to compete with the so called practical man who knows things because he has done them before!

We would like "Consulting Engineer" to point out a profession which is not overcrowded. It has been stated that the remuneration of the average New York lawyer is about the salary of the average New York policeman. *McClure's* for February and March has interesting articles on the remuneration of the average clergyman and average doctor and states that the one receives less than $600 per annum and that only 23 out of 70 doctors at a medical convention were making expenses.

"Consulting Engineer" in stating that "it is the survival of the fittest or rather of the man who can do work at the lowest figure," confuses the contractor and the consulting engineer. The survival of the latter depends upon his ability to show how work can be done at the lowest figure and make a net saving in spite of his larger fee.

Is higher education worth while? Judging by the vast sums spent upon it annually in this country and abroad, it is. If a young man desires to enter the engineering profession, can he do better than enter a reputable engineering school? Suppose that he is uncertain as to his life's work. Are not the four years spent in meeting the high requirements necessary for graduation from a first-class engineering school, a tangible asset of inestimable value in meeting the demands that the unknown future will produce?

In the College of Technology of this institution, "Consulting Engineer's" query was settled on what we suppose

to be good business principles. Every technical professor is encouraged to practice his profession. When this involves the use of laboratory equipment, a portion of his fee is returned to the laboratory and is used in buying additional instruments. It is not regarded as the business of the engineering profession, but that of the dean of the college concerned to investigate any rumor in regard to neglect of duty or of incompetency on the part of any professor and to take proper steps to maintain the reputation of the college for high-grade training.

The advantages of this method are obvious. It secures and holds able professors, giving them the diversity required by active and virile minds. The strong courses attract students who are awake to the inevitable competition which awaits them on the outside regardless of the fields which they may enter after graduation. The college gains the respect of the community when its professors are quoted as authorities on professional questions. If a professor is incompetent in the practice of engineering, the fact is soon recognized and reflects discredit on him and his college and none will note this quicker than his students and his dean.

Why is it that the attendance in colleges of technology has increased by leaps and bounds? Is it not because the vague, misty instruction of the pure theorist has given way to the more rigorous training that can be given only by men who have successfully practiced their professions? Why is it that many men attend engineering colleges who never intend to practice engineering? Is it not because they recognize that the laboratory training of the engineering student is true cultural training and develops the mind for any pursuit that the graduate may desire to enter?

W. H. P. Creighton, U. S. N., Retired,
Dean, College of Technology, Tulane University.
New Orleans, La., Feb. 22, 1915.

Sir: I have read with interest the communication "Competition by Professors in Engineering Schools," contributed by "Consulting Engineer," and your editorial comment.

There can be no doubt that a policy by which engineering teachers are permitted to engage in outside professional work is fraught with possibilities detrimental to the best interests of the institution with which they are connected, and especially, perhaps, of the students under their direction. It is no less certain, however, that unless opportunities for outside professional work are offered in some measure, the existing difficulty of attracting and holding strong men in the field of engineering teaching would be greatly emphasized. Not only would it cut off a legitimate and, it may be, necessary source of revenue, but also because wide-awake men will not allow themselves to be denied the stimulus that comes from such activities, and without which the tendency would be for their teaching to degenerate into deadly routine.

In my judgment the right procedure in such matters should be determined with careful regard to the interests involved, and, that restrictive measures should be definitely formulated for the guidance of a given department, according to the environment of the institution and other surrounding circumstances.

It may be interesting and helpfully suggestive to others to quote the following regulations governing outside professional activities observed in the Department of Engineering of the University of Pennsylvania, regulations having been formally approved by the University authorities:

No restriction is placed on outside work not involving the use of University apparatus or power, except that it must be confined to limits compatible with the full discharge of University duties, and that the name of the University or the official title of the individual concerned in his relation to the University, must not appear on any reports rendered.

Work involving the use of University apparatus is subject to the following restrictions:

1. Ordinary routine commercial tests are not permissible.

2. Investigations, tests, etc., involving apparatus or power, or both, may be undertaken with the approval of the head of the department, under any one of the following conditions:

(a) Under an arrangement by which the cost of materials, special apparatus, time of machinist or laborers, etc., are assumed by outside parties, and the work is conducted by one or more members of the teaching staff without compensation, but with the privilege of publishing the results in the technical press or in a paper presented to a technical society. In such cases it is to be understood that the program of the investigation and its technical features generally shall be planned either independently by the members of the teaching staff concerned, or in coöperation with the party or parties who assume the above mentioned expenses.

(b) Under an arrangement similar to the foregoing, except that the program is planned wholly by outside parties, and its execution merely supervised by one or more members of the teaching staff, and at their option. In that case the members of the teaching staff would be paid a moderate fee at a time rate, and the interested parties would be charged for the use of the power and apparatus in addition to the items enumerated under (a), all of these charges being reported to the treasurer of the University, subject to his collection. Under this arrangement the publication of the results is optional with the interested parties, but if published it must be stated that they were conducted in the laboratories of the Department of Civil Engineering of the University of Pennsylvania, and the manuscript must be previously approved by the Department as to the accuracy and completeness of the experimental data.

(c) Under an arrangement by which a professor or assistant professor may conduct an investigation on his own responsibility and at a compensation on the usual scale for work of this character, in which case he will reimburse the University for the actual cost of labor and machinist's time, and pay 10 per cent. of his fee, to cover the cost of power and apparatus, into the petty cash laboratory fund.

Some of the considerations underlying these regulations may be stated briefly as follows:

Inasmuch as the University is located in a large city where ample facilities exist for routine commercial tests, it should not enter this field by allowing the use of its laboratory facilities to instructors for that purpose. Such work is purely commercial, of little or no scientific interest, and competition in that field on the part of the University, even though done at the usual scale of prices observed in outside circles, is unfair and undesirable in that, (1) the instructor commands the use of apparatus which does not belong to him; (2) parties requiring such work are frequently disposed to have it done by some one connected with the University primarily with a view of using (misusing) the name of the University in connection with the results; (3) in that it is apt to give rise to advertising, commercial circularizing, etc., detrimental to the best interests of the University.

An arrangement of the kind described in paragraph 2 (b) is, of course, entered upon only for exceptional reasons. Such arrangements have been made with a number of firms and corporations, the general situation being that the department commanded certain apparatus essential for the conduct of proposed tests and not available elsewhere in Philadelphia. In that connection it should be recognized that a higher institution of learning may be regarded as a quasi-public institution, with im-

plied duties to the public, from whom its support is largely derived. Under the circumstances stated, it seems unfair in principle to make use of apparatus in the way indicated contingent on the payment of professional fees on the usual scale to anyone connected with the department, inasmuch as his expert knowledge would be neither required nor desired, but would, in that case, be paid merely in order to gain access to apparatus belonging to the University.

EDGAR MARBURG,
University of Pennsylvania.

Philadelphia, Feb. 18, 1915.

NOTES AND QUERIES

In the new Youngstown, Ohio, reinforced-concrete ordinance, the inspector, who must report to the city officials regarding the construction of buildings, is employed by the owner, not by the contractor as stated in the note in "Engineering News," Feb. 4, 1915, p. 225. In this respect the Youngstown ruling is a copy of the Cleveland, Ohio, ordinance.

The concrete pavement which was renovated according to methods described in "Engineering News," Jan. 28, 1915, p. 172, was laid according to the Hassam patented process and not by the ordinary nonpatented methods now common in concrete pavements and roadways.

Indiana Sanitary and Water-Supply Association*

The eighth annual meeting of the Indiana Sanitary and Water Supply Association was held at Indianapolis, Feb. 23 and 24, 1915. The program included a score of papers and addresses, a half dozen committee reports, a banquet, a theater party and a visit to the new pumping plant of the Indianapolis Water Co.

INDIANA PUBLIC UTILITY COMMISSION—The work of the Commission was reviewed by Thomas Duncan, Chairman. The Commission has been limited by a lack of funds for staff salaries, only one of the engineering staff receiving more than $1800 per year. In all cases but one, thus far, where public-service property has been appraised and rates reduced, the utility has appealed to the courts. "If the Public Service Law is going to work in this way," Mr. Duncan stated, "the operation of the Commission will be a failure, utility regulation will be abandoned and public ownership will become universal." Of the seven water utilities which have appeared before the Commission to date, rates only have been involved in five cases, while in two cases service alone was questioned, and purification was ordered. On the whole, there has been less complaint as to the character of service and product of the water utilities than of the other utilities under regulation.

Some phases of the work of the Commission were dealt with in the report of the Committee on Water-Works Management and Accounts, which was presented by C. H. Hurd, Chairman. Replies to a series of questions sent out to utility managers, asking for their experience in the use of Public Service Commission's forms, were summarized in part as follows:

In a general way the classification is good. The division of the classes of service and the definition of commercial and industrial use are not in accordance with the best utility practice. The system, generally, is considered a benefit to the utility.

Probably the greatest problem with which the Commission has to deal is that of valuation. The Committee believes that there should be no difference in the actual value of the property, whether the valuation is made for rate-making or any other purpose.

The question of depreciation is also troublesome, frequently because there is confusion between the actual depreciation and renewal charge. Appreciation is sometimes used conversely with depreciation. This is only true in the case where the increase in value is due to causes within the property itself.

The term "going value," like depreciation, deserves a different name. Undoubtedly an operating plant has a greater value than a nonoperating plant, and whatever this value may be called, the utility is entitled to earn a return on it.

PUBLIC HEALTH SERVICE STANDARDS FOR WATER USED ON INTERSTATE CARRIERS—A paper on this subject was read by H. E. Jordan, of Indianapolis. He objected to the standard on the ground that city water-supplies, if used on railroad cars, are virtually subjected to the standard, while studies of well known filtered water-supplies show that those having a higher proportion of B. coli than is allowed by the Public Service Standard have had a good effect upon public health. The average in the Lawrence, Mass., plant, for a period of 17 years, has been 10.8% positive results in 1-c.c. examinations for B. coli, and at Indianapolis 3.1%. The assumption that bacteria of the coli group do not multiply in water was questioned—studies on the bacterial multiplication in a hypochlorite treated water made in the Indianapolis Water Co.'s laboratory showing more than 100% increase in bacteria of the colon type after 24 hours standing.

In discussing this paper, Prof. E. B. Phelps, of the United States Public Health Service, stated that the railroad companies are making no objections to the standard, and that the cost of improving any city supply to meet the standard involves no large expense by the railroads.

Dr. Edward Bartow, Director of the State Water Survey, of Illinois, detailed studies on 100 samples of water taken from railway cars entering the city of Chicago, in which it was shown that 73% did not conform to the standard.

STREAM SANITATION—Prof. Phelps said that everyone got along pretty well when Saturday night was "bath night," and that the daily bath is "a sanitary luxury rather than a sanitary necessity." He made the plea for cleaning up streams on the same basis as that of taking the daily bath, because it looked better and seemed better.

TREATMENT OF INDUSTRIAL WASTES—Langdon Pearse, Engineer of the Sanitary District of Chicago, stated that, considered as a load on sewage-disposal works, the packing-house wastes of Chicago are equivalent to one-fourth the total population of the Sanitary District. Domestic sewage contains 1 to 5 cu.yd. of solid matter per million gallons, stock-yards wastes, 6 to 10, and tannery wastes, 10 to 100 cu.yd.

BUSINESS—After hearing the report of a Joint Committee on Amalgamation with the Indiana Engineering Society, the Association decided to drop the idea, but voted in favor of holding a joint meeting, or simultaneous meetings, with the Society in 1916.

Officers were elected as follows: President, J. N. Hurty, Secretary State Board of Health, Indianapolis, Ind.; First Vice-President, H. O. Gorman, Chief Engineer Public Service Commission, Indianapolis; Secretary, W. F. King, Assistant Secretary State Board of Health, Indianapolis.

*Reported for "Engineering News" by H. E. Jordan, Engineering Chemist, 113 Monument Place, Indianapolis, Ind.

Redevelopment of Old Canal Power at Cohoes Falls, N. Y.

SYNOPSIS—The history of the old Cohoes canal power development is briefly sketched. The principal features of the new hydro-electric plant are described—utilization of old stone dam and first-level canal, 10,000-hp. turbines, 12,000-volt generators, large steel headgates, ice protection. The benefits secured from the canalization of the Mohawk River for navigation are presented.

The old hydraulic canal power development at Cohoes, N. Y., after a useful life approaching 85 years has finally been superseded by a hydro-electric development of modern type. The redevelopment at this point is of particular interest because of the history of the company, the design of the old system by the late J. B. Francis, the father of modern hydraulic engineering, and the character of the new works.

The Old Cohoes Canal Power

The Cohoes Co. was incorporated in 1826 as a power and manufacturing company with a capital of $250,000, which was increased in a few years to $500,000. The company purchased a large plot of land in what is now the city of Cohoes, and also a narrow strip along the river on the other side as a protection against intruders. It secured also the entire water power, and control of the river from half a mile above Cohoes Falls to a mile below—except for a reservation made by the state for canal purposes. At this point the drainage area above is about 3500 sq.mi.; the total fall is some 120 ft.

From 1831 to 1840 the company built three wood dams across the river above the falls. Finally the existing masonry dam was built in 1865; it is 1443 ft. long and cost $180,000. At the time, it was one of the monumental pieces of work of the country. With this dam it is possible to divert the entire low-water flow of the Mohawk, and the company has the right to do so, provided it does not interfere with navigation. (The Erie canal takes a supply from the Mohawk, above the company's dam, for a long flight of locks through Cohoes to the Hudson level. The Champlain Canal is contr[illegible] at the Mohawk by a dam in Cohoes.)

The first power canal was completed in 1834 and [illegible] 1¾ mi. long. It gave a fall of 18 ft. In 1843, a sec[illegible] level canal was added and the first one was somewhat [illegible]tered so that both could make use of the old Erie c[illegible] bed, which had been secured by exchange of land dur[illegible] the enlargement of this waterway. A third canal, [illegible] a mile long and giving a fall of 23 ft., was also built in 1843, using part of the old Erie canal. The fourth and fifth levels, about half a mile long and each giving a drop of 20 ft., were added about 1880. The fourth level has subsequently been greatly extended. At the time of these early developments, it was necessary to subdivide the total fall available into such small units, as water-wheel design had not far advanced. The company also has a sixth-level canal taking water from above the state dam which controls the Champlain canal. This last level is not affected by the redevelopment, and a small electric station here will still be run—in parallel with the new one.

Power was supplied at $20 per hp. year to tenants whom the Cohoes Co. induced to settle on their land. As much land was leased and included under this charge as was necessary or agreed upon, being generally in accordance with the amount of power taken. As a result, the expenses for motive power and ground rent of the largest mills in the earlier stages scarcely exceeded $1000 a year. The water was measured in the canal as supplied to the mills and the power bills based on this. In recent years the land of the company has been largely occupied and the low-stage flow of the Mohawk has been practically all utilized. Indeed the largest mill, in order to obtain extra power required by the development of its business, was obliged to build a steam station.

The total canal power developed was in the vicinity of 10,000 hp. All this load can be carried by one unit of the new station. The inefficiency of the old hydraulic system was due not only to the low efficiency of the wheels employed but also to the necessity of bypassing water from the upper to the lower canals so that constant flow

Fig. 1. Cohoes Falls and Power House of Cohoes Co.

should be assured irrespective of the demands of the upper mills. Then, too, there was considerable leakage, and in winter considerable water was wasted in ridding the canal of ice.

The Cohoes Co. eventually gave up all manufacturing, though there was an identity of interest with some of the mill companies. Shortly after the control changed, a few years ago, plans were undertaken for the redevelopment.

The final disposition of the old canal beds has not been settled. There are a number of sewers, both storm and sanitary, which have been allowed to empty into the canals within the city, and serious inconvenience might be caused if the canal flow should be wholly cut off before these connections can be cared for.

New Development

General Plan—In the redevelopment, the old canal has been utilized to a point just above the first mill. Here the channel has been enlarged to make a forebay, and a gate house has been placed near the edge of the bluff, as shown in Fig. 2. Three penstocks (eventually to be five) are shown in Fig. 3 going down to the power house some 75 ft. below. The total head available is 96 ft.

The power house is located in the old bed of the river on land recently granted the company by the state. The river bed here is encircled by precipitous walls and access at the station is secured by the novel scheme of a bridge and elevator tower. On the river side of the station, a retaining wall has been built to prevent tail-water interference from the flood flow of the Mohawk. The station is 170x67 ft. in plan; a steel frame with brick curtain walls rests on a concrete substructure. The elevator and stair tower is of steel and brick; the connecting bridge is steel.

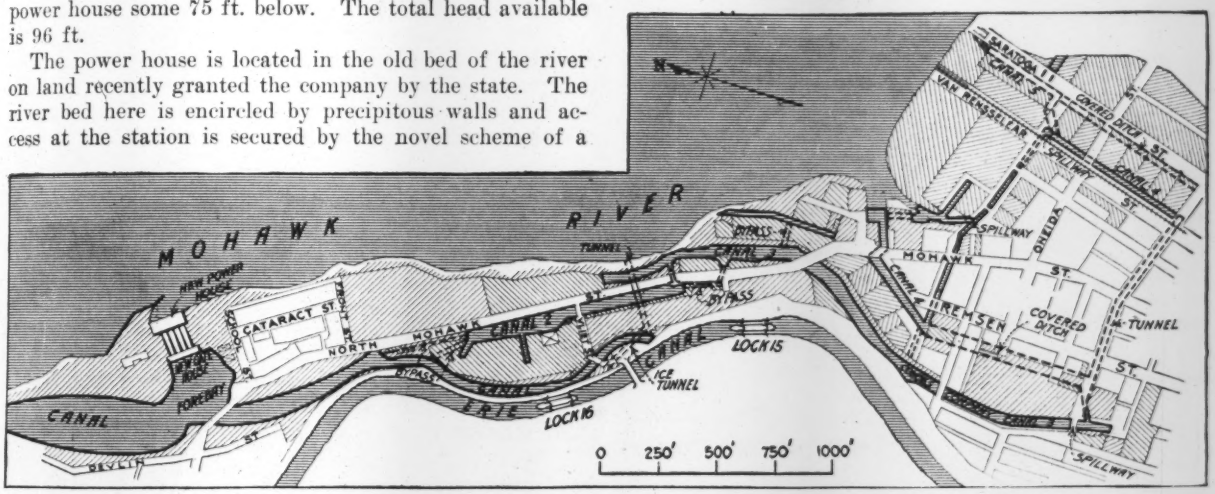


Fig. 2. Plan of Old Canal Hydraulic Power Development of Cohoes Co.

The gatehouse substructure is largely reinforced because of the embedded penstock connections under low head; the superstructure is similar in design and construction to the power station.

As power is to be supplied about the Albany district within a radius of some 10 miles, the generators have been wound for the potential required for this service, 12,000 volts, eliminating step-up transformers. Step-down transformers are required however for the local supply and for local street lighting.

Generating Station—The arrangement of apparatus shows the adaptation of accepted practice to the local situation rather than the intrusion of many novelties. Three 10,000-hp., generating units have been installed, and space has been reserved for two more. Each of these is a 10,000-hp. 185-r.p.m. vertical-shaft turbine, carrying the rotating field of a 9000-kv.a. 12,000-volt 40-cycle alternator. Each rotor is supported on a Kingsbury bearing which is carried by a bridge yoke on the generator frame. There is the familiar flyball governor controlling the oil supply to cylinders ("servomotors") whose pistons shift the guide-vane ring, a band brake on the shaft coupling, lignumvitæ guide bearing, etc. The volute casing is a heavy iron casting embedded in the foundation. The draft tube is molded in the concrete substructure and changes from a circle of 7½ ft. diameter to an oval 11½ ft. high and 31 ft. long, reducing the runner discharge velocity from about 18 ft. per sec. to 4½.

A large part of the switch house casement is necessarily taken up by the 11-ft. penstocks. There are several open bays, however, and these have been utilized for the resistance grids of the generator field-circuit control. The heat released in the basement is led up the elevator tower and discharged out at the top when desired, or deflected into the first and gallery floors of the switch house of the building.

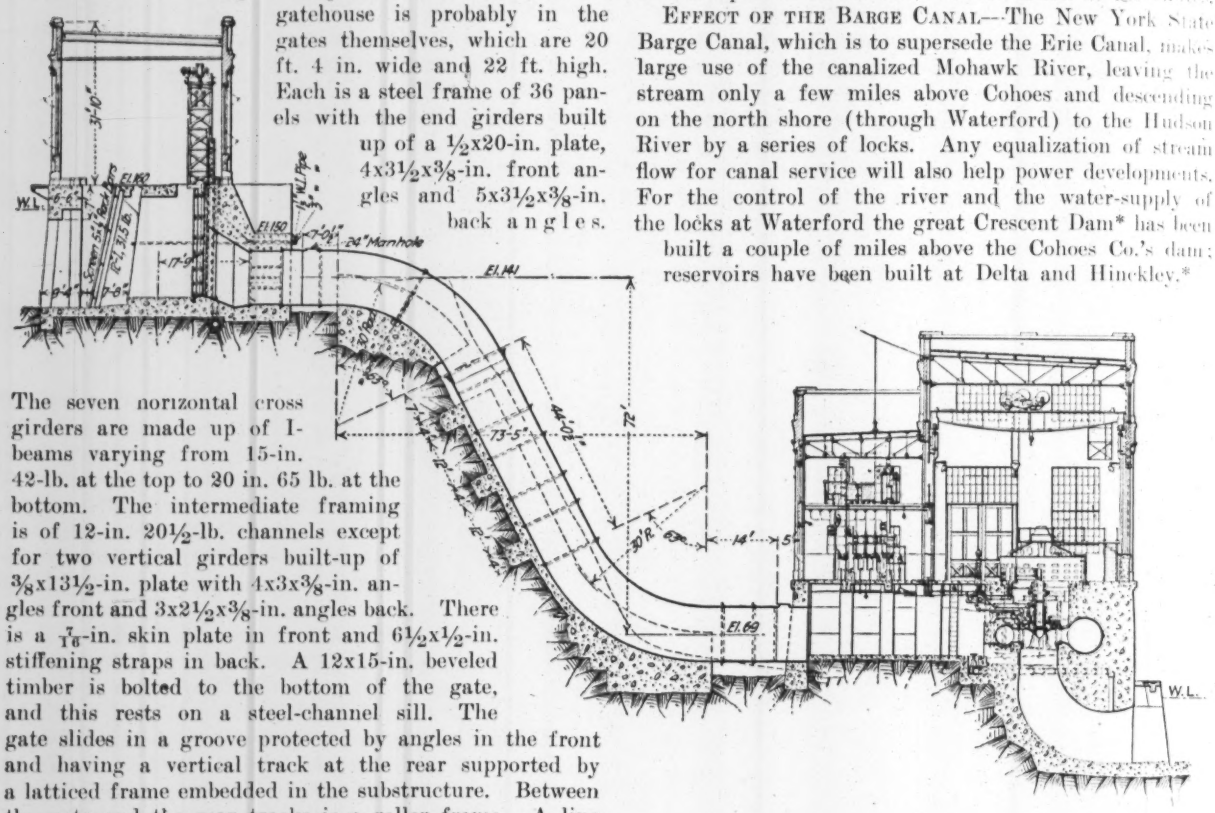
The switch house at generator-room level is about half taken up by 12,000-volt oil switches and busbars. The rest is occupied by the 12,000-volt transformer switches, by two step-down transformer banks changing from 12,000-volt three-phase to 2300-volt two-phase for the local supply, by the exciter and storage-battery switchboards, the governor oil pumps and the exciters (all motor driven), a storage-battery room and a locker and toilet room. The gallery floor of the switch house is occupied about half by the 12,000-volt feeder reactances and lightning arresters, with the rest for the office, operating gallery and 2300 and 12,000-volt instrument and control boards. The 2300-volt. switch room has the starting and running busbars for the exciter and pump motors, transformers and control panels for the constant-current (street lighting) circuits and the local feeder busbars.

The 12,000-volt feeders are led directly up from the reactances and lightning arresters through roof bushings, connecting with the transmission line which is deadended on the main station wall. The street-lighting feeders, eight in number, leave the station through the

outer wall of the switch house directly from the constant-current transformers. The 2300-volt local mill feeders and the tie lines to the older power station of the company (located below at the Champlain canal), both eight in number, are led out directly from the local feeder busbars which are interposed between the step-down transformers and the feeders.

PENSTOCKS—The supports are piers in rock. This is a Hudson River shale which disintegrates under weather, and, to protect the rock foundations, the concrete piers have virtually been extended to form a single block with the footing. The upper elbow is anchored into rock at the top of the bluff and is supported on a large block of concrete. Below this elbow on the tangent length of pipe is a slip expansion joint.

GATEHOUSE—The greatest point of interest about the gatehouse is probably in the gates themselves, which are 20 ft. 4 in. wide and 22 ft. high. Each is a steel frame of 36 panels with the end girders built up of a ½x20-in. plate, 4x3½x⅜-in. front angles and 5x3½x⅜-in. back angles.



The seven horizontal cross girders are made up of I-beams varying from 15-in. 42-lb. at the top to 20 in. 65 lb. at the bottom. The intermediate framing is of 12-in. 20½-lb. channels except for two vertical girders built-up of ⅜x13½-in. plate with 4x3x⅜-in. angles front and 3x2½x⅜-in. angles back. There is a $\frac{7}{16}$-in. skin plate in front and 6½x½-in. stiffening straps in back. A 12x15-in. beveled timber is bolted to the bottom of the gate, and this rests on a steel-channel sill. The gate slides in a groove protected by angles in the front and having a vertical track at the rear supported by a latticed frame embedded in the substructure. Between the gate and the rear tracks is a roller frame. A line is run between a hook on the gate and a pin on the gate-hoist frame, passing under a sheave on the roller frame, so that the rollers rise at their natural rate of half the gate speed, irrespective of any tendency to slip, etc. The rollers and tracks are protected from trash by a fixed baffle plate. The sides of the gates are sealed in the armored groove by a long rod covered with rubber hose; any ordinary leakage is drained off back of the gates.

For raising the gates, the steel supporting framework carries a long shaft above each gate. Each is motor driven and has a cable drum on either end; from one drum a steel cable passes through a two-sheave block (hooked into an eye in the top of the gate), over two sheaves on the frame, and across to a similar arrangement for the other corner of the gate. By this use of a single line supporting the gates, the weight and travel of each end are compensated. The hoists are controlled from the station operating gallery ordinarily, [illegible] they can be operated in the gatehouse.

ICE PROTECTION—Special provisions for prevent[illegible] of ice troubles are necessary in this climate. From [illegible] it is seen that the rack and gate structures are [illegible] the building will be warm enough so that the heat [illegible] ient will outward to the water, preventing the st[illegible] of ice particles. The water level is sufficiently abo[illegible] skimming wall, so that floating ice and large trash [illegible] kept out. At the south end of the gate-house, as shown in Fig. 4, are ice sluices by which any accumulation of ice can be poled out of the forebay and slid into the river. The control gates here are let down in front of the retaining wall instead of being pulled up, and the ice is allowed to pass over them. This facilitates shutting off flow in spite of ice or trash accumulation at the chutes.

EFFECT OF THE BARGE CANAL—The New York State Barge Canal, which is to supersede the Erie Canal, makes large use of the canalized Mohawk River, leaving the stream only a few miles above Cohoes and descending on the north shore (through Waterford) to the Hudson River by a series of locks. Any equalization of stream flow for canal service will also help power developments. For the control of the river and the water-supply of the locks at Waterford the great Crescent Dam* has been built a couple of miles above the Cohoes Co.'s dam; reservoirs have been built at Delta and Hinckley.*

FIG. 3. SECTION THROUGH COHOES POWER STATION, PENSTOCKS AND GATE HOUSE

A study of all the available gagings shows that the minimum dry-year flow at Cohoes is in the vicinity of 200 sec.ft.—not including some 270 sec.ft. used (in part wasted) for the operation of the present Erie Canal. With the regulation of the Mohawk obtained from the Delta and Hinckley storage, it is probable that a dry-year flow of some 800 sec.ft. will be obtained above Cohoes, but 200 to 300 sec.ft. necessarily will be diverted by the Barge Canal.

This gives a minimum available flow of roughly 550 sec.ft., which would allow the continuous development of only some 5000 hp. at the new Cohoes plant; but the canal and forebay for the plant and the stillwater above

*See "Engineering News," June 9, 1910.

the old stone dam give considerable storage, making feasible a present installation of some 30,000 hp., of which about half is to be considered secondary power. The station would be economical at 50,000 hp. installed capacity if there were some steam auxiliary; this probably is provided in the plans of the promoters of this redevelopment, for an enlargement of the present capacity is possible with two empty wheel pits in the station.

Organization of Work, Etc.—The engineering work

Fig. 4. Gate House Ice Sluice, Cohoes, N. Y.

of this redevelopment has been done by Sanderson & Porter, of New York. The construction has been carried out under force account by the Cohoes Co. (Lorenzo Semple, President; W. P. Parsons, General Manager; T. E. Murray, Consulting Engineer; A. C. Polk, Superintendent of Construction). The turbines were designed and built by the Platt Iron Works of Dayton, Ohio; the electrical equipment was furnished by the General Electric Co., of Schenectady.

Water Disinfection in America*

Of about 110 water-works practicing disinfection some 80% use hypochlorite of lime and the balance use liquid chlorine. Some 63% of the cities use disinfection as an adjunct to some other method of treatment, generally filtration, and 37% use disinfection alone.

Installation costs of disinfection run from $4 to $2400 per million gallons but do not exceed $100 per unit in 42% of the cases. Treatment costs run from 10 to 50c. and average 25c. per million gallons.

For construction materials, about 65% of the works report concrete or else concrete-lined tanks for hypochlorite. About 20% report tanks of wood and the rest wood with various linings. Piping is generally of iron and valves of brass, the handiest rather than the most durable material being chosen.

The installation "materials commonly used which seem to have shown the greatest resistance to the corrosive effects of hypochlorite are concrete tanks, lead pipe and rubber composition."

The strength of the hypochlorite used is tested as purchased by only 29% of the works reporting. Of the tests reported the available chlorine ranged from 42 to 15%, with an average of 33%, and with two cases where the maximum was 2½ times the minimum strength.

The fact that some 75% of the communities reported on "failed to indicate that any improvement in typhoid or other health conditions had resulted" from disinfection, combined with other statements, indicates that "in a large percentage of the cases" disinfection is a "precautionary measure." Notable typhoid reductions are reported at Cleveland, Evanston, Baltimore, Trenton and elsewhere. At Trenton the average typhoid death rate was 267 before and has been 74 since disinfection.

As to tastes and odors, 40% of the reports stated that none traceable to hypochlorite had been noted and of those which reported such trouble the average dose causing it was 14 lb. per million gallons. In many places 20- to 30-lb. rates, and in one case a 37-lb. rate, had "not given rise to objectionable tastes and odors."

Discussion—Asked to speak on the relative merits of hypochlorite and liquid chlorine, F. E. Hale, of the Department of Water Supply, New York City, said he thought liquid chlorine would displace hypochlorite on account of the greater certainty of regulation of the liquid chlorine, and F. D. West, of the Philadelphia works, told how the cost of treatment in that city had been reduced 30 to 40% since liquid chlorine displaced hypochlorite. Mr. Hale, commenting on the recent remarkable typhoid death rate of New York City (9.6 per 100,000 in 1912, 6.7 in 1913 and 5.9 in 1914) said he thought it due to the pasteurization of the milk supply and to anti-typhoid innoculation, rather than to chlorination, especially since the heaviest typhoid drop has been in Brooklyn and Queens boroughs, where the water is not disinfected. F. D. West, without attempting to explain why, stated that typhoid deaths in Philadelphia dropped from a total of 255 in 1913 to 124 in 1914, the rate in 1914 being only 7.5 per 100,000.

Congress Promotes Builders of Panama Canal

Congress has extended its thanks to and authorized the promotion of members of the United States army, navy and public health service who participated in the construction of the Panama Canal. The bill authorized the promotion of Col. George W. Goethals and Surgeon-General Wm. C. Gorgas to the rank of Major-General, Col. H. F. Hodges and Lieut.-Col. Wm. L. Sibert to Brigadier-General, and Commander H. H. Rousseau, U. S. N., to Captain. The act further provides for the retirement of any of these officers on three-quarters pay at any time hereafter. The bill is now before the President for signature.

Exports from the United States during the month of January exceeded the value of imports during that month by $145,536,000, the largest trade balance in favor of the United States ever recorded. The total value of exports was $267,800,000, which was about $64,000,000 greater than the exports of January, 1914. The imports were $122,265,000, which was $32,000,000 less than the imports of 1914.

*From a paper by Francis F. Longley, of Hazen, Whipple & Fuller, 30 East 42d St., New York City, presented on Feb. 25, 1915, to the New York Section of the American Water Works Association. The information is based on replies to about 110 of some 240 inquiries sent by Mr. Longley to water-works in the United States and Canada believed to be using or to have used some means of disinfection. So little was learned regarding the use of ozone or ultra violet rays that the paper was confined to chlorination by either hypochlorite of lime or liquid chlorine. It should be noted that while hypochlorite began to come into use in 1908, liquid chlorine has been used only two or three years.—EDITOR.

News of the Engineering World

Garbage Disposal, Chicago

The Chicago garbage-disposal bond issue of $750,000 is to be distributed approximately as follows: Improvements to present municipal garbage-reduction plant at 39th and Iron Sts., with new mill house, drier building and additions to extractor plant and equipment, $385,000; completion of incinerator now under construction at 95th St. and E. Stony Island Ave., $170,000; completion of Bridewell crematory at 26th St. and California Ave., $15,000; Goose Island incinerator and disposal plant (site not yet determined), $75,000; equipment for handling and removing garbage and refuse, $70,000; technical staff, $30,000.

The New York Alien Labor Law Sustained

The New York Alien Labor Law was upheld as constitutional by the Court of Appeals, the state court of last resort, in a decision handed down on Feb. 25. The decision was concurred in by all the justices of the court, except Judge Collin. It is stated that the case will be carried to the U. S. Supreme Court on the ground that the law in question violates the Fourteenth amendment to the Federal Constitution, which was the opinion held by a lower New York court. The opinion just rendered, however, says:

> To hold that this statute violates the Federal Constitution would be to ignore the contrary judgment expressed in the constitutions and legislation of many other states.

The New York Alien Labor Law was enacted 17 years ago, but has remained practically a dead letter until a few months ago, when some of the labor unions of New York undertook to secure its enforcement. The law makes the employment of alien labor on public works in New York a misdemeanor, and contractors or public officials employing such labor are guilty of a misdemeanor and liable to fine and imprisonment. The law further requires that contracts on which alien labor is employed shall be subject to forfeiture. The chaos that would be produced if such action were taken on the New York subway contracts now in force, as was pointed out in these columns some months ago, will doubtless prevent any such radical action being taken. The labor unions who are back of the movement to enforce the law will probably be satisfied if it is strictly observed hereafter without attempt to make its provisions retroactive. As it is, the difficulty in securing sufficient skilled American labor accustomed to the work of shoring and similar tasks in subway construction is likely to cause material delay in the subway work. The letting of additional contracts for the subway work has been held up for some time awaiting the court decision on the constitutionality of the Alien Labor Law. Now that this decision has been given, it is probable that these contracts will soon be advertised. To incur the further long delay involved in waiting for a decision by the U. S. Supreme Court, with the large chances that this decision would be adverse, would be most unwis-

Gov. Whitman has announced that he will req the Legislature to relieve the subway situation. T Spring bill, already pending, would repeal the alien la law; but to be of help it would require an amendm validating the existing subway contracts, in which a clauses which have been violated. The Central Federat Labor Union of New York City has announced its in tention to fight any repeal of the law.

Another Tunnel Proposed for the East River

Twin tunnels under the East River between the boroughs of Manhattan and Queens at about 60th St. have been proposed by certain interests to take the place of the present scheme whereby the 59th-60th St. line of the new subway system crosses the river on the Queensboro bridge, which will have to be strengthened and at the same time reduced in vehicular traffic capacity. The plan has been approved by the Board of Estimate and Apportionment but has not been acted upon by the Public Service Commission. It has also been approved by various citizens' organizations, although it appears to have received its initiation in a proposal by the Degnon Contracting Co., which holds the contract for the Manhattan approach to the bridge (under the present scheme), to build tunnels for $4,500,000, at the same time deducting $500,000 from its present contract price.

According to a report by Maurice Deutsch, consulting engineer to various property interests in the vicinity of the bridge and subway, the increased cost of tunnels over the bridge route would be under $2,000,000, which would be more than made up in a few years by the saving in maintenance and in the increased value of the bridge for growing vehicular traffic. He also states that it is only a question of a few years before the tunnels would have to be built, even though the bridge route were now selected.

Proposed Agreement on St. Paul Gas Rates

A settlement of the differences over gas rates is in prospect between the City of St. Paul and the St. Paul Gas Light Co. On Apr. 9, 1914, Prof. E. W. Bemis and C. L. Pillsbury, in a report to the mayor, recommended a net rate of 85c. per 1000 cu.ft. The report was accepted and an ordinance drawn ordering a reduction to this price. The company served an injunction on the city and took the case into court. Recently there have been negotiations toward a settlement and Messrs. Bemis and Pillsbury have recommended that this should be based on an 85c. rate effective Jan. 1, 1916. It is expected that company and council will accept this basis.

St. Paul paid $1 per 1000 cu.ft. to Mar. 1, 1913, and 95c. to Jan. 1, 1914 (85c. for 10,000 to 50,000 cu.ft. and

75c. above 50,000); since then the base rate has been 90c. Annual consumption is 5308 cu.ft. per capita; 1913 sales were 5,588,000 cu.ft. per mile of main. No tax is paid on gross earnings. The company has a coal-gas plant of 2,000,000 cu.ft. daily capacity. In the twin city of Minneapolis, the gas rate is 80c.; consumption per capita, 6546 cu.ft.; 1913 sales per mile of main, 4,464,000 cu.ft.; gross-earnings tax, 3c. per 1000 cu.ft.; present plant, water gas—coal-gas works expected to be built soon.

Ontario Municipal Railways Organize

Several hundred municipal officials representing Ottawa urban and rural municipalities met in Toronto on Feb. 24, and organized "The Hydro-Electric Railway Association of Ontario." This is a permanent union aiming (1) to promote a scheme of "radial," or interurban, electric railways owned by the municipalities and operated by the Provincial Hydro-Electric Commission, (2) to secure necessary legislation and government aid and (3) to prevent renewal of private-road charters. (As noted in ENGINEERING NEWS, Apr. 23, 1914, p. 935, and Nov. 12, 1914, p. 1000, 11 towns approved such a plan at recent elections).

The officers of the new association are: Honorary President, Sir Adam Beck; Honorary Vice-Presidents, Hon. I. B. Lucas and W. K. McNaught; President, J. W. Lyon, of Guelph; Vice-Presidents, Thomas Church, of Toronto, C. M. Graham, of London, A. F. Wilson, of Markham, and J. Buller, of Peterborough. A board of management and a permanent secretary will be appointed.

A City Plan Commission for Shreveport, La., has been created by a city ordinance. No additions to the city can be laid out without the approval of the Commission, and the Commission is also given other purely supervisory powers. We are informed by O. A. Wright, of the Atlas Oil Co., who is Chairman of the Commission, that a simple yet inexpensive plan has already been prepared for the city, and that this plan has been unanimously endorsed by the Shreveport Chamber of Commerce.

The Report on the Edison Fire prepared jointly by the National Fire Protection Association and the National Board of Fire Underwriters has just been issued, under date of Jan. 30, 1915. It may be procured from F. J. T. Stuart, New York Board of Fire Underwriters, 123 William St., New York City, for 25c. The report comprises 61 pages of text, numerous photographs and some drawings and is by far the most exhaustive analysis of the fire and its effect on the structures of the plant that has yet appeared.

A New Process for Increasing Production of Gasoline from crude petroleum is announced by the Federal Bureau of Mines as having been discovered by Dr. Walter F. Rittman, of the Bureau. According to Secretary Lane, the new process will increase the output of gasoline from petroleum 200% or more and the process is to be patented by Dr. Rittman, and the patents dedicated to the public. Dr. Rittman has also developed a process for producing toluol and benzol from crude petroleum in connection with the production of gasoline. These processes were worked out by Dr. Rittman in the chemical laboratories of Columbia University, New York. Dr. Rittman was formerly an instructor in chemistry at Swarthmore College and was later chemist for the United Gas Improvement Co., Philadelphia. He became connected with the Bureau of Mines last summer.

The Disposal of Industrial Wastes at the Chicago packing-house plants is under consideration by a committee appointed recently to represent the packing firms in discussing the matter with George M. Wisner, Chief Engineer of the Sanitary District of Chicago, and C. D. Hill, Chief Engineer of the Board of Local Improvements. The engineer member of the committee is C. A. Jennings. They will take up plans for remedying the pollution and nuisance existing in the Bubbly Creek arm of the river, due to the discharge of wastes from the packing houses. The first step to be considered is the renovation of the sewer system in that section of the city. Then the practicability of installing screens will be considered, and finally the value of sedimentation at the houses and for the plants collectively. The packing firms have expressed their willingness to coöperate with the authorities and to do whatever is necessary to relieve the situation. The Union Stock Yards & Transit Co. will also cooperate in the work; this company has for some time been operating a screen at the outlet of its Morgan St. sewer.

The Patent on Concrete Arch Reinforcement issued to Edwin Thacher, Jan. 10, 1899, No. 617,615, has been sustained in a decision by the U. S. District Court for the district of Maryland in a suit brought by Mr. Thacher against the Mayor and City Council of Baltimore for infringement of his patent in the construction of the Fallsway viaduct. The patent in suit showed a concrete arch having pairs of deformed bars embedded near the interior and exterior surfaces of the arch, the specifications stating that "the bars act as the flanges of beams to resist bending moments, whereas the shearing stresses, which are small, are taken by the concrete alone." At the time this patent was issued it was common practice in constructing reinforced concrete arches to imbed steel beams in the arch bent to conform to the curve of the arch intrados. From the above quoted language it would appear that the main object of the invention was to reduce the amount of metal required for arch reinforcement. The patent contains three claims, the first of which is as follows: "The combination with abutments and a concrete arch spanning the intervening space of a series of metal bars in pairs, one bar of each pair above the other, near the intrados and extrados of the arch and extending well into the abutment, each bar of a pair being independent of the other, substantially as described." A patent showing a similar construction was issued to Fritz von Emperger, June 1, 1897, No. 583,464. Mr. Thacher filed affidavits, fixing the date of his invention at a time prior to the date of von Emperger's application and a patent was therefore issued to him. The judge in his decision said: "There are other patents in which the metallic reinforcement is on or near the surface of the arch, but it is not in the form of bars in pairs each independent of the other arranged one above the other and at least one of each pair extending well into the abutments." The Fallsway viaduct was illustrated and described in "Engineering News" of July 3, 1913. It is a structure over 1500 ft. long and is said to have cost about $2,000,000. The court ordered a decree for an injunction and an accounting.

PERSONALS

Mr. R. O. Wynne-Roberts, Consulting Engineer of the City Council of Regina, Sask., will sever his connection with the city on May 1.

Mr. D. W. Rider, General Superintendent of the Kansas City (Mo.) Terminal Ry. Co., has been given a leave of absence, due to ill health.

Mr. G. P. Smith has been appointed Consulting Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with headquarters at Cincinnati.

Mr. H. M. Church has been appointed Division Engineer of the Baltimore & Ohio R.R., with headquarters at Baltimore, Md. Mr. Church succeeds the late W. I. Trench.

Mr. Lee O. Kellogg, recently a member of the editorial staff of "Engineering and Mining Journal," has joined the staff of the "Engineering Magazine" as Associate Editor.

Donald C. Wedgeworth, Assoc. M. Am. Soc. C. E., Resident Engineer on the New York State Barge Canal at Syracuse, N. Y., has been appointed Resident Engineer for the Schenectady district.

Mr. M. S. Slattery, who was formerly State Boiler Inspector of Ohio, has been appointed Commissioner of Smoke for the City of Cleveland. Mr. Slattery succeeds Mr. E. P. Roberts, M. Am. Soc. M. E.

Mr. B. A. Worthington, formerly President of the Chicago & Alton R.R., has been appointed receiver of the Cincinnati, Indianapolis & Western Ry., a subsidiary of the Cincinnati, Hamilton & Dayton Ry.

Mr. Floyd A. Walter will hereafter represent the firm of Harrison & Schaffer, Engineers and Chemists, of Easton, Penn., with headquarters at its newly opened New York City office, 28 East 14th St.

Mr. Jacob Paul Jones Williams, Assoc. M. Am. Soc. C. E., formerly Assistant Professor of Structural Engineering at

the University of Minnesota, has joined the editorial staff of the "Engineering Record," New York City.

Mr. Hadley Baldwin has been appointed Assistant Chief Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., with headquarters at Cincinnati, and the office of Chief Engineer of Maintenance-of-Way has been abolished.

Mr. Percy E. Barbour, M. Am. Inst. M. E., formerly Mining Engineer and Manager of the Uwarra Mining Co., Candor, N. C., has jointed the editorial staff of "Engineering and Mining Journal." Mr. Barbour is a graduate in civil engineering of the Worcester Polytechnic Institute, class of 1896.

Mr. E. P. Kearney, recently Vice-President of the Texas & Pacific Ry., at New Orleans, has been elected President of the Wabash R.R. Mr. Kearney was in the service of the Texas & Pacific Ry. for the past two years. Previous to that he was Assistant to Mr. B. F. Bush, President of the Missouri Pacific Ry.

Mr. Fred Winton Sarr, Assoc. M. Am. Soc. C. E., of Syracuse, N. Y., has been appointed Second Deputy Highway Commissioner of New York under Commissioner Edwin Duffie. He will be in charge of the maintenance and repair work of the department. Mr. Sarr succeeds Mr. Paul Schultze, M. Am. Soc. C. E., who has been Deputy Commissioner of Highways since June, 1913.

Mr. Gustav J. Requardt has been appointed Acting Division Engineer of the Disposal Division of the Baltimore Sewerage Commission, to succeed Mr. H. C. McRae, Assoc. M. Am. Soc. C. E. Mr. Requardt has been connected with the Commission since 1909, and in his new capacity will take charge of the operation and construction work of the disposal plant. His headquarters will be at Colgate, Baltimore County, Md.

Messrs. Louis B. Marks, F. Am. Inst. E. E., and Julian E. Woodwell, M. Am. Soc. M. E., Consulting Engineers, 103 Park Ave., New York City, announce that they will dissolve partnership on May 1, 1915. Mr. Woodwell will locate his offices at 8 West 40th St., where he will continue the general practice of mechanical engineering, and Mr. Marks will retain his offices at 103 Park Ave. and will specialize as heretofore in illuminating engineering.

Mr. J. E. Aldred, President of the Consolidated Gas, Electric Light and Power Co., of Baltimore, Md., has resigned to become Chairman of the Board of Directors of that company. Mr. H. A. Wagner, Vice-President, has been elected to succeed Mr. Aldred. Mr. Wagner became associated with the company in 1908, as Consulting Engineer, and in 1911 was made Vice-President. He is Vice-President of the National Electric Light Association and President of the Baltimore Tube Co.

Mr. Charles C. Elwell, M. Am. Soc. C. E., Chief Engineer of the Connecticut Public Utilities Commission, has been appointed a Member of that Commission, to serve for six years, with a salary of $5000 a year. Mr. Elwell was born at Belfast, Maine, in 1855. He is a graduate in civil engineering of the University of Maine, and began his railroad career in 1882, with the old New York & New England R.R. When the Connecticut Public Utilities Commission was formed, in 1911, he was selected as its Chief Engineer and Inspector.

Mr. Paul Hannagan, Director of the Department of Streets of Lawrence, Mass., under the present commission form of government, was shot and seriously wounded while working at a drafting table in his office, on Feb. 23. His assailant, Mr. Dennis H. Finn, has been active in Lawrence politics for a number of years, having served in the City Council, the State Legislature and as an assessor. More recently he has worked as a city laborer and had lately espoused the cause of the unemployed. Mr. Hannagan is retained by the City of Boston as Consulting Engineer on paving.

Mr. Harry G. D. Nutting, Consulting Engineer, of Milwaukee, Wis., has been appointed Manager of the Engineering Department of John E. De Wolf Co., Investment Bankers of that city, and will have charge of the company's public utility properties. He will continue his private practice but will have his office at the company's. Mr. Nutting was formerly engineer of the Wisconsin Railroad Commission, and more recently was Assistant to the President of the Wisconsin Public Service Co., Wisconsin Railway, Light & Power Co. and the Evanston (Ill.) Railway Co.

Mr. Henry Eltinge Breed, M. Am. Soc. C. E., an engineer of the New York State Highway Department from 1901 to 1911, and until recently Terminal Engineer of the New York State Barge Canal, has been appointed First Deputy Highway Commissioner of New York, under Commissioner Edwin Duffie, and will have charge of all construction work. Mr. Breed graduated from Colgate University in 1900 and began his engineering experience as a draftsman with the Newport News Shipbuilding & Drydock Co., Newport News, Va. In 1912 he made an extended tour in Europe to study [illegible] and waterway engineering, and until December, 1914, in private practice. Mr. Breed succeeds Mr. George A. Ri[illegible], M. Am. Soc. C. E., who has been First Deputy Highway [illegible] missioner since May, 1913.

Mr. C. A. Paquette, Chief Engineer of Maintenance of Way of the Cleveland, Cincinnati, Chicago & St. Louis [illegible] has been made Chief Engineer. Mr. Paquette was born [illegible] Detroit, Mich., in 1872. He graduated from Notre D[illegible] University in 1891, and the same year entered the ser[illegible]

C. A. PAQUETTE

(Photo by Matzene—Chicago)

of the Lake Shore & Michigan Southern Ry. as a rodman. In 1902 he became associated with the Big Four Ry. as Superintendent of the Chicago & White Water division. Mr. Paquette succeeds Mr. G. P. Smith, as noted elsewhere, and will have his headquarters at Cincinnati.

OBITUARY

Nathan Hopkins Heft, formerly Chief of the Electrical Department of the New York, New Haven & Hartford R.R., died Feb. 25 at Bridgeport, Conn. Col. Heft was prominent in street railway circles, having been at various times President of the Bridgeport Traction Co., the Stamford Street R.R. and the Meriden Street R.R. Besides his traction interests, Col. Heft owned mines in Colorado and an oil refinery in Pennsylvania.

Frank Asbury Sherman, Professor of Mathematics at Dartmouth College, Hanover, N. H., died Feb. 26, in his 74th year. Prof. Sherman was born at Knoxville, Maine, and graduated from Dartmouth in 1870. As a student he enlisted in a Maine regiment in the Civil War. Two years after graduation he joined the Dartmouth faculty, retiring in 1911 as professor emeritus. Prof. Sherman left one son and two daughters.

Col. James B. Quinn, Corps of Engineers, U. S. A., retired, died at his home in Woodstock, Md., Feb. 23. Col. Quinn graduated from the Military Academy at West Point in 1866, and was assigned to the Engineer Corps as Second Lieutenant. He was assigned to the improvement work being carried on at that time in the harbors of Michigan, and the following year was engaged in the survey of the Union and Central Pacific railways. He was retired from active service in 1907.

Charles Dudley Lamson, President of the Worcester (Mass.) Gas Light Co., died at his home in that city Feb. 12, from cerebral hemorrhage. Mr. Lamson was born in Cam-

bridge, Mass., in 1841. He was graduated from the Lawrence Scientific School of Harvard University in 1866. After graduation he entered the service of the old Boston Gas Light Co., where he remained for over 20 years. In 1888 he was elected President of the Worcester Gas Light Co.

Collinson Pierrepont Edwards Burgwyn died at Richmond, Va., Feb. 24, in his 64th year. Col. Burgwyn was one of the best known civil engineers of Virginia. He was born in Northampton County, N. C., and received his early education in Richmond and Boston, Mass., schools. In 1869 he entered Harvard College, and graduated with the degree of B. A. He graduated from the Lawrence Scientific School of Harvard in civil engineering in 1876. Col. Burgwyn had a great deal to do with the various engineering projects in Richmond and throughout the state. He at one time was connected with the U. S. Coast & Geodetic Survey in the work of deepening the channel of the James River. He was at various times President of the Virginia Dredging Co., the Petersburg Iron Works, the Bermuda Hundred Construction Co., and Vice-President of the Warwick Park Transportation Co. Recently he was connected with the building of the hydro-electric plant on the Meherrin River at Emporia. Col. Burgwyn was a member of the Richmond Society of Engineers and of several clubs.

ENGINEERING SOCIETIES

COMING MEETINGS

ILLINOIS WATER SUPPLY ASSOCIATION.
Mar. 9-11. Annual convention at University of Illinois. Secy., Edward Bartow, Urbana, Ill.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 16-18. Annual meeting at Chicago, Ill. Secy., E. H. Fritch, 900 So. Michigan Ave., Chicago, Ill.

LAKE MICHIGAN WATER COMMISSION.
Mar. 19. Meeeting at Milwaukee, Wis. Secy., Edward Bartow, Director, Illinois Water Survey, Urbana, Ill.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Mar. 6. Meeting in Pittsburgh, Penn. Secy., W. T. Snyder.

AMERICAN CHEMICAL SOCIETY.
Mar. 31-Apr. 3. Meeting in New Orleans. Secy., Charles L. Parsons, Box 505, Washington, D. C.

Montana Institute of Engineers—At a recent meeting of the Institute the following officers were elected: President, C. E. Durlan, City Engineer, Billings, Mont.; Secretary, C. C. Widener, City Engineer, Bozeman.

Iowa Engineering Society—The following officers have been elected for the ensuing year: President, W. H. Kimball, Davenport; Vice-President, M. G. Hall, Centerville; Directors, J. W. Budd and S. M. Woodward. The Secretary will shortly be elected by the Executive Committee.

Granite Paving Block Manufacturers' Association of the United States—A conference was recently held in Boston, Mass., of the executive board of the Association and representatives of the paving-block cutters' union. The object of the meeting was to promote mutual coöperation in the making of better blocks. It is planned in the near future to hold a meeting in New York City of members of the executive board of the Association, paving-block cutters and other employees of the quarries, pavers, inspectors and other men interested in granite-block pavements.

American Concrete Pipe Association—At the annual convention held at the Auditorium Hotel, Chicago, Feb. 15-16, it was voted to extend the activities of the association. A reorganization committee was appointed to revise the constitution, and was instructed to include provision for standing committees to carry on investigations and other work. A Committee on Specifications and Tests of Sewer Pipe was appointed to coöperate with a similar committee of the American Society for Testing Materials. Officers for 1915 were elected as follows: President, B. Blair, Woodstock, Ont., Canada; Vice-President, J. J. Hammen, Spencer, Iowa; Secretary, E. C. Hanson, 538 South Clark St., Chicago.

Society of Technical Associations' Secretaries—The first annual meeting of the Society of Technical Associations' Secretaries was held at 29 West 39th St., New York, Feb. 27, 1915. Eighteen members were present, representing 21 of the leading national engineering societies and railway associations. The following officers were elected:

President, Harry D. Vought, Secretary, New York Railroad Club.
First Vice-President, F. L. Bishop, Secretary of the Society for the Promotion of Engineering Education.
Second Vice-President, Charles Warren Hunt, Secretary of the American Society of Civil Engineers.

These three officers together with the following four elected representatives form the Executive Committee of the Society:

William M. Corse, Secretary, American Institute of Metals.
F. L. Hutchinson, Secretary, American Institute of Electrical Engineers.
J. E. Fairbanks, Assistant General Secretary of the American Railway Association.
R. B. Owens, Secretary, Franklin Institute.

This being the first meeting of the new Society no papers had been prepared, but addresses were made dealing with the purposes and proposed activities of the Society by Dr. Edgar Marburg, Calvin W. Rice, G. P. Conard, Charles Warren Hunt, Harry D. Vought, H. H. Norris and Joseph W. Richards.

It is expected that within a few months another meeting of the Society will be held at which papers will be presented, formally opening a discussion of subjects of interest to members of the association in connection with their activities as secretaries of technical associations. The Secretary of the new association is Bradley Stoughton, who is also Secretary of the American Institute of Mining Engineers, 29 West 39th St., New York.

American Water Works Association, New York Section—The first winter lunch and meeting was held on Feb. 25. Morris R. Sherrerd was reëlected as a member of the executive committee.

A paper on the "Present Status of Disinfection of Water-Supplies" was read by Francis F. Longley. (See abstract of paper and discussion elsewhere in this issue.)

A discussion on "How to Determine the Size of Tap and Meter" was opened by Jacob Klein, Inspector of Meters and Water Consumption, New York City. The only fair basis (for New York—Editor) is the floor area of the building served, omitting the basement and all projections having areas of less than 150 sq.ft. A $\frac{5}{8}$-in. tap is allowed for 7500 ft. of floor space, a $\frac{3}{4}$-in. tap for 15,000 sq.ft., and the equivalent of one $\frac{5}{8}$-in. tap for each additional 10,000 sq.ft. of floor area. No meters smaller than the tap are permitted, but a meter one size larger than the tap may be used. W. W. Brush, also of the New York Water-Works, said that, except for special industries, the relation between unit floor area and water consumption, quite regardless of the character of occupants, is surprising. Allen Hazen and A. W. Cuddeback urged the importance of keeping down the size of the meters, in view of the increased slip with the larger sizes.

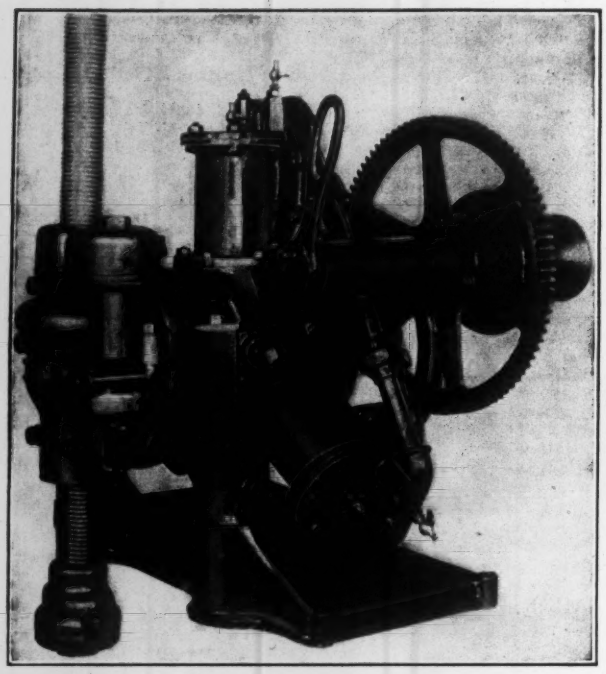
A joint discussion on "Do We Need a Standard Meter Specification?" was opened by A. W. Cuddeback, for the purchasers, and John W. Kelley, of the National Meter Co., for the manufacturers. Mr. Cuddeback favored a simple standard specification, covering mixture of metal for various meter parts, overall sizes, accuracy and senstitiveness, and moving speed. Mr. Kelley expressed willingness to meet the water-works engineers half way if they strongly desired to attempt a standard, but seemed to think difficulties and extra expense would result, especially in conection with a standard mix of metal, suitable for all works and waters. The other manufacturers seemed quite willing to let Mr. Kelley serve as their spokesman in this case and took no part in the discussion. A few water-works men supported Mr. Cuddeback's argument for a standard.

Appliances and Materials

Light-Weight Diamond Drill

For the new lake and land water tunnels at Chicago, extensive diamond-drill borings have been made in order to determine the depth and character of the rock in which the tunnels are to be driven. This work was done with a light drill, built by the Standard Diamond Drill Co., of Chicago, and shown in the illustration on the next page.

The drill is operated by a three-cylinder high-speed engine designed to eliminate vibration, as steady running is important in relation to the durability of the cutters. The swiveling head has two sets of feed gears and these can be furnished for speeds ranging from 50 to 2500 revolutions per inch of feed, thus adapting the machine to rock of varying degrees of hardness. The size of core is 2 in. for a depth of 400 ft., or $1\frac{1}{8}$ in. for a depth of 600 ft. The drilling rig proper weighs only about 300 lb. The drill is shown mounted on a base for surface work (weighing 75 lb.), but for underground work the sleeves on either side of the head are fitted to columns on which the rig slides. The winch head is for the line handling the drill rods.



DIAMOND DRILL FOR CHICAGO EXPLORATION

For the lake borings noted above, in water as deep at 40 ft., the drilling outfit was mounted on a platform 14 ft. square supported by 65-ft. piles having their tops about 10 ft. above the water. The drill was suspended from a tripod of 30-ft. cedar poles, giving ample headway for handling 24-ft. lengths of drill rods. The light weight of the drill enabled it to be handled easily, and it was taken to and from the work each day on a scow.

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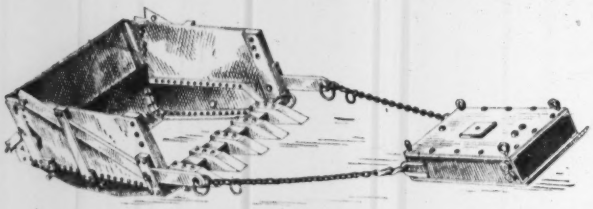
Adjustable Dragline Excavator Bucket

A recent development in dragline excavator buckets is shown in the accompanying sketch. The bucket proper is a bottomless box with heavy teeth on a cross bar, and under each side a heavy skid. Within is pivoted a frame of two side plates and a curved back plate; this tilts to release the contents when the bucket is hauled back to make another cut. The bucket is attached by chains to a steel "turtle" which rides on the ground in front. The hauling line may be hooked to this box, or passed around a horizontal sheave within it. The chains from the "turtle" are connected to the ends of two bent levers extending along the sides of the bucket and pivoted at its forward end. In position for digging, the levers are latched down at the back so that the mouth of the bucket is forced into the ground. When the bucket is loaded, a dog holding the levers is released, allowing their rear ends to rise, and raising the mouth of the bucket about 4 in. clear of the ground. The bucket is returned to position by a backhaul cable. This bottomless bucket is sufficient where material is moved without being lifted. For lifting, an open-end box is fitted into the bucket, the loaded box being lifted out and dumped by a derrick. The bucket is built in sizes of ½ to 2 yd. capacity; the 1½-yd. bucket carries a 1-yd. box.



SCRAPER BUCKET AND "TURTLE"

The inventor has designed portable excavator outfits with engine, boiler, drums and derrick mounted on a wide-tired wagon. One special outfit has a duplicate set of drums operating a pair of buckets. These buckets are connected to a tail rope passing over sheaves anchored to piles or dead men so that as one bucket makes its loading cut the other empty bucket is returned to the pit. These excavators are the invention of R. P. McCormick, who has used them on his own work. They are being handled by Geo. F. Smith, 816 N. 18th St., St. Louis, Mo., and the Chicago Builders Specialties Co., Old Colony Building, Chicago.

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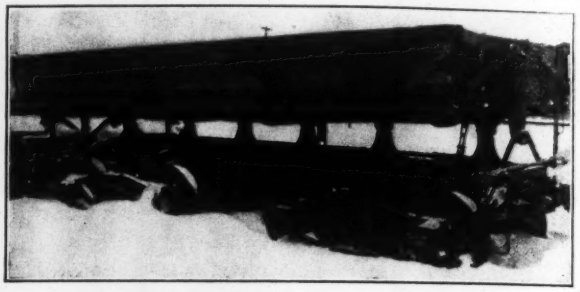
Side Door for a Dump Car

A simple and sturdy type of side door for contractors' dump cars has recently been designed by the Improved Car Side Co., 50 Church St., New York City. The door is of solid lumber stiffened and protected at the top and bottom with 72-lb. rails, to which are secured the gudgeons connecting the end operating bars, as illustrated. The manufacturer claims that doors of this type have been in trial use for over a year handling heavy rock spoil without visible deterioration.



STRONG SIDE DOOR FOR DUMP CARS

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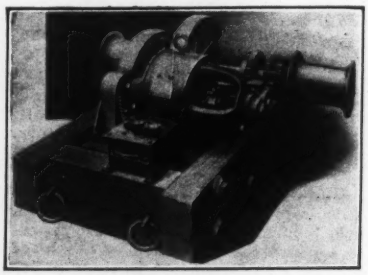
Contractor's Portable Power Winch

The portable power winch shown in the accompanying illustration was developed particularly for construction work on the New York subways, but has been used elsewhere on a variety of work. The machine is made in two sizes—for rope speeds of 152 and 178 ft. per min., and with 5- and 7½-hp. motors, respectively. The larger hoist complete, as shown, weighs about 1850 lb. It is made by the Dobbie Foundry & Machine Co. of Niagara Falls, N. Y.



PORTABLE POWER WINCH

As built for New York work, 550-volt direct-current compound motors were used. In lifting material out of subway excavation, a light frame with sheave is set up over the opening, and the hoist rope run over the sheave and given a few turns around the drum. The machine is used also in helping loaded teams up heavy grades.

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Automatic Gas-Furnace Control

An automatic gas and air mixer for gas furnaces, which has been extensively used in Europe, is now being introduced in the United States by the Selas Co., 521 West 23d St., New York City. The machine automatically measures the gas and air passing through it and maintains a mixture of constant proportions notwithstanding barometric changes. A rotary pump, forming part of the machine, delivers the mixed gas and air at any desired pressure. With conditions thus kept favorable for perfect combustion, control of the furnace is much easier and a considerable saving in fuel is claimed.

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Another Batch-Type Concrete Mixer

The Eureka Machine Co., of Lansing, Mich., is now building a batch mixer in addition to its line of continuous mixers. The drum is formed by two cones with blades and buckets. Either pivoted side loader or batch hopper is furnished. There is a positive-type water measuring tank. The drive is either gasoline engine or electric motor.